

Ground Water and Drinking Water in the
Santa Clara Valley : A White Paper

0
15
383.G76
184
5
BRARY

DALKE

TD22553836761984C.6

SANTA CLARA VALLEY WATER DISTRICT
LIBRARY
5750 ALMADEN EXPRESSWAY
SAN JOSE, CALIFORNIA 95118

GROUND WATER AND DRINKING WATER IN THE SANTA CLARA VALLEY:

A WHITE PAPER

Issued By:

California Department of Health Services
California Regional Water Quality Control Board #2
Santa Clara County Public Health Department
Santa Clara Valley Water District
U.S. Environmental Protection Agency

October 5, 1984

GROUNDWATER AND DRINKING WATER IN THE SANTA CLARA VALLEY:

A WHITE PAPER

EXECUTIVE SUMMARY

This paper discusses the sources of drinking water in the Santa Clara Valley, and the ways in which those water resources are managed to provide an adequate supply of safe drinking water to the Valley's 1,400,000 residents. It discusses contamination problems which have affected the Valley's drinking water or may do so in the future, and the activities of various governmental agencies to respond to those problems.

Drinking water in the Santa Clara Valley comes from three sources: ground water drawn from wells; surface water imported through the South Bay and Hetch Hetchy Aqueducts; and impounded local surface water. Overall, about half of the drinking water in the Santa Clara Valley is groundwater, and half is surface water. Large volumes of imported and local surface water are used to recharge the ground water basin artificially, both to prevent the depletion of the aquifer and to store water supplies at a relatively low cost.

Residents in different parts of the valley are served by different water sources, or combinations of sources. In most of the valley ground water is used to supply at least a portion of user needs. Some areas rely entirely on treated surface water, however; and others use only ground water. Nineteen water retailers—eleven municipal water agencies and eight large private water companies—deliver water to the Santa Clara Valley's consumers, under regulation by the California Department of Health Services (DOHS).

The City and County of San Francisco operate the Hetch Hetchy Aqueduct, which brings water from the Sierra Nevada to parts of the Bay Area. Hetch Hetchy water supplies about one-fifth of the Valley's drinking water. It is treated at four facilities between Yosemite and the Santa Clara Valley, where it is sold to water retailers.

The Santa Clara Valley Water District (SCVWD) operates two treatment plants for the water imported from the Sacramento River Delta through the South Bay Aqueduct, and sells the treated water to the water retailers. About one-fourth of the Valley's water supply comes directly from the South Bay Aqueduct. The SCVWD has recently been increasing its ability to move treated surface water to most parts of the Valley. The SCVWD is also responsible for the overall management of the Valley's ground water resources, including recharge of the aquifer.

Most of the water retailers in the area draw water from the aquifers for distribution to consumers; the nineteen major retailers operate a total of about 300 wells. More than 200 additional small water systems which serve 199 or fewer connections each (most have about 10 connections) also draw on the aquifers. They are regulated by the Santa Clara County Public Health Department. Numerous private wells also exist; these receive little formal regulatory scrutiny. In the northern part of the valley, the small systems and private wells rely on about 1,200 wells. There are also about 4,000 wells in South County, an unknown number of which are in operation. Together, these 5,200 wells produce about 14 percent of the ground water used in the valley for non-agricultural purposes (or about 7 percent of the area's total drinking water supplies).

Executive Summary - 2

Altogether, ground water supplies slightly more than one-half of the drinking water used in the Valley. Although all surface water used for drinking in the Valley is treated prior to distribution, most of the the ground water is untreated. Ground water from 29 of the public water supply wells in the Santa Clara Valley is chlorinated prior to use; water from 12 of these wells is also fluoridated. Some small water systems in the area also chlorinate their ground water.

The Santa Clara Valley encompasses three ground water subbasins: the Santa Clara, extending southward from the county line to Coyote; the Coyote, from Coyote to Morgan Hill; and the Llagas, from Morgan Hill to Gilroy. Of the three, the Santa Clara subbasin serves the largest number of high-yielding public water supply wells. This subbasin is composed of a "confined zone" near San Francisco Bay and a "recharge" or "forebay zone" further south. The confined zone is characterized by a thick silty clay layer 100 to 200 feet below the surface, which separates an upper aquifer—serving most of the shallow private wells—from the lower aquifer on which most of the public wells draw. This clay layer helps keep contaminants that may be released near the land surface from reaching the deep confined aquifer. However, the confining layer does not provide complete assurance against contamination of deep wells. This clay layer does not exist in the recharge zone.

Most public water supply wells in the Santa Clara subbasin tap either the lower aquifer in the confined zone or the deeper portions of the aquifer in the recharge zone. Recharge of the ground water aquifer occurs in the recharge zone, in stream beds downstream from reservoirs and in specially constructed percolation ponds in and around south San Jose.

The Santa Clara Valley traditionally has had access to high quality drinking water. Water quality problems do exist, however. High nitrate levels persist in the southern portion of the valley and in some parts of North County. Because of this contamination, the DOHS and the County Health Department have stated that water in some South County areas is unsuitable for use by infants. Chlorination of surface water has resulted in levels of trihalomethanes (THMs) that approach and sometimes exceed the federal standard (100 parts per billion, running annual average) in some treated drinking water. The SCVWD is changing its water treatment process in order to lower THM levels in South Bay Aqueduct water. As a result, THM levels have been reduced by over 50%, and are within federal and state standards. Pesticides may contaminate ground water supplies in the Valley if they leach into shallow aquifers, and may also be present in water imported through the South Bay Aqueduct; monitoring practices, however, have not detected such contamination.

Executive Summary - 3

Leaks and spills of solvents and related chemicals from industrial facilities in the Santa Clara Valley have gained a great deal of recent publicity. Contamination has been discovered at and around 89 underground solvent storage tanks in the valley. As a result, 13 public water supply wells drawing from the recharge zone aquifer have been contaminated. An additional 46 private wells have been found to contain detectable levels of chemical contamination: 35 drawing from the shallow aquifer in the contained zone in Mountain View, and 11 using the recharge zone aquifer in South San Jose.

The clay layer in the confined zone helps keep contaminants present in the shallow aquifer from reaching the lower aquifer. No wells drawing from the deep aquifer are known to be contaminated. Some of the 10,000 or so abandoned agricultural wells in the area may act as conduits for the contaminants to reach the deep aquifer. As a result, the SCVWD has initiated a program to identify and seal the most critical deep abandoned wells.

Groundwater contamination does not always result in drinking water contamination, largely because most public wells in the Santa Clara Valley are perforated in the deep aquifers. Moreover, remedial measures can be an important supplement to the natural features that help protect underground drinking water. These measures can take several forms. Once a plume of contamination has been defined, pumping can help keep it from spreading further and keep contaminants away from drinking water wells. Contaminant concentrations in the plume can be reduced by pumping the ground water. In addition, many contaminants could be removed from drinking water by treatment processes, either at the well or elsewhere in the water supply system. Finally, wells drawing on contaminated ground water can be closed. With the exception of treatment prior to use, all of these remedial actions have been taken in the Santa Clara Valley. To date, four public water system wells and 38 private wells have been closed in the valley.

Companies in the Santa Clara Valley are generally cooperating with regulatory agencies to remedy the contamination problems that have been identified. The ground water clean up efforts in the Santa Clara Valley are among the most extensive in the nation. Local governments in the valley, in cooperation with industry and environmental groups, have devised and are implementing an innovative Hazardous Materials Management Ordinance to intensify monitoring of chemicals in existing tanks and to ensure greater control at new storage facilities. Once fully implemented, this ordinance will enhance longterm protection of the Santa Clara Valley's aquifers.

TABLE OF CONTENTS

	<u>Page</u>
Executive Summary	i
Foreword	vi
The Santa Clara Valley's Water Supply System	1
Overview of the Regional System	1
Sources of Drinking Water by Service Area	3
Monitoring Practices	5
Drinking Water Quality and Contamination Issues	8
Ground Water Contamination from Industrial Sites and Gasoline Storage	8
PCB-Contaminated Soils	16
Trihalomethanes	16
Nitrates	17
Salt Water Intrusion	18
Other Drinking Water Issues	19
Bacterial Contamination and Septic Tanks	19
Sewer Wells and Dry Wells	19
Sewer Lines	20
Contaminant Infiltration to Water Supply Pipes	20
Impoundments and Operating and Abandoned Landfills	20
Sewage Treatment Plant Effluent and Sludge Storage	21
Pesticides	21
Illegal Waste Disposal	22
Giardia	22
Corrective Efforts and Future Actions	23
United States Environmental Protection Agency	23
EPA Region 9 Superfund Program	23
South Bay Ground Water Contamination Task Force	24
EPA's Integrated Environmental Management Project	25
Regional Water Quality Control Board	26
Santa Clara Valley Water District	27
California Department of Health Services	27
Santa Clara County Department of Public Health	28
Local Government	28
Water Purveyors	29
Industry	29
Appendices:	
Factors Influencing the Transport and Fate of Contaminants in Ground Water	A-1
Hydrogeology and Ground Water Conditions in the Santa Clara Valley	B-1
Glossary	G-1

Ground Water Production in the Santa Clara Subbasin	Table 1
Characteristics of Major Water Purveyors	Table 2
Drinking Water Standards and Monitoring Requirements in California	Table 3
DOHS Recommended Action Levels for Selected Chemicals	Table 4
Status of Monitoring Efforts	Table 5
Santa Clara Valley Contamination Sites	Table 6
Contamination Levels at Some Sites	Table 7
Contaminated Drinking Water Wells	Table 8
Total Trihalomethane Levels in 1983 and 1984	Table 9
Nitrate Levels in South Santa Clara County Wells	Table 10
Ground Water Basins and the Confined Zone	Figure 1
Water Conveyance, Treatment and Distribution System	Figure 2
Overall Drinking Water Supply Patterns (Santa Clara Subbasin)	Figure 3
Locations of Wells Serving Major Water Purveyors	Figure 4
Areas Served by Major Water Purveyors	Figure 5
San Jose Water Company Service Zones	Figure 6
Locations of Contamination Sites	Figure 7
South San Francisco Bay Sites Proposed for National Priorities List	Figure 8
Schematic Illustration of Natural or Man-Made Hydrogeologic Factors	Figure A-1
Factors Affecting Contaminant Transport and Fate	Figure A-2
Ground Water Basins and the Confined Zone	Figure B-1
Schematic Cross Section for Santa Clara Subbasin	Figure B-2
Ground Water Elevations	Figure B-3
Typical Water Level Hydrograph for Santa Clara Subbasin	Figure B-4

FOREWORD

This White Paper on ground water and drinking water in the Santa Clara Valley is intended to compile facts that will be readily accessible to the public and decision makers. This paper provides information on the sources of drinking water, their present quality, and the potential for future contamination.

Some of the information in this paper will be outdated and augmented soon, as additional data become available from ongoing water monitoring efforts and ground water investigations. This paper is not intended to be used as the sole basis for regulatory decisions by any agency. It should, however, provide a common structure for continuing discussion and analysis.

The sponsoring agencies consider the information presented here to be generally accurate as of early September, 1984 (except where an earlier date is specified). Since the situation in the Santa Clara Valley is changing constantly, however, data presented here are subject to revision at any time. In particular, new drinking water monitoring data are expected to become available for major water supply systems in the valley on a staggered basis between September 1984 and early 1985.

This paper is a mutual effort of five agencies:

California Department of Health Services
California Regional Water Quality Control Board #2
(San Francisco Bay Region)
Santa Clara County Public Health Department
Santa Clara Valley Water District
U.S. Environmental Protection Agency

The paper draws extensively on work underway in EPA's Integrated Environmental Management Project (IEMP), a wide ranging assessment of health risks from toxic pollutants in the Santa Clara Valley and of methods to manage those risks. EPA is cooperating closely on the IEMP with elected officials of local government through its Intergovernmental Coordinating Committee (IOC), and with state and local government, industry, public interest groups, and the academic community through its Public Advisory Committee (PAC).

EPA welcomes comments on this paper, particularly on questions of factual accuracy. They should be addressed to the IEMP staff at EPA Region Nine, 215 Fremont Street, San Francisco, California 94105.

THE SANTA CLARA VALLEY'S WATER SUPPLY SYSTEM

Overview of the Regional System

A complex water supply system serves the Santa Clara Valley and its 1,400,000 residents. Drinking water in the valley comes from ground water, impounded local surface water, and surface water imported through the Hetch-Hetchy and South Bay Aqueducts. Ground water supplies about half of all the drinking water used in the valley, but more than half the people in the valley drink some ground water, usually blended with surface water.

Ground Water

The aquifers in the Santa Clara Valley store, purify, and transmit water to users more efficiently and at much lower costs than do reservoirs, treatment plants, and pipes. Public or private wells withdraw ground water from all three major ground water subbasins—the Santa Clara, extending southward from the county line to Metcalfe Road, the Coyote, from Metcalfe Road to Cochrane Road, and the Llagas, including Morgan Hill and Gilroy. These subbasins are depicted in Figure 1. Ground water is the only source of drinking water in most of the Coyote and Llagas subbasins. In the Santa Clara subbasin, local and imported surface water are also used to meet demand.

The Santa Clara subbasin consists of a "confined zone" near San Francisco Bay and a "recharge zone" in areas further from the bay. The confined zone is characterized by a thick silty clay layer 100 to 200 feet below the land surface, which separates an upper aquifer—serving most of the shallow private wells—from the deeper confined aquifer on which most of the public wells rely. The approximate boundaries of this confining layer (which does not exist in the recharge zone) are shown on Figure 1.

This clay layer helps keep contaminants that may be released near the land surface from reaching the deep confined aquifer. However, the confining layer does not provide complete assurance against contamination of deep wells.

The ground water aquifers in the Santa Clara Valley are used intensively. Large volumes of water are removed by wells, creating pumping stresses that alter "natural" ground water patterns. Wells or groups of wells with high yields draw down the water from the surrounding area, creating "cones of depression" that can change ground water flow directions, accelerate flow rates, and pull water from areas near the land surface to deeper zones. (Appendix B, which provides additional detail on the hydrogeology of the Santa Clara Valley, includes a ground water elevation map that shows the major cones of depression in the valley.)

Ground water extraction must be roughly balanced by recharge (seepage of water into the aquifer) to prevent sinking ground water levels and a potential recurrence of land subsidence problems seen in the past. Current extraction rates exceed the amount of water that would naturally be introduced to the aquifers by rainfall and surface water, so imported and local surface waters are collected, stored, and used to recharge the aquifers. Artificial recharge occurs in stream beds downstream from reservoirs and in specially constructed percolation ponds throughout the valley's recharge zone (though predominantly

in south San Jose). Major recharge facilities are shown on Figure 2. Additional recharge facilities are planned for the Coyote and Llagas subbasins, where future demand is expected to exceed natural aquifer recharge.

Surface Water

Figure 2 also shows the imported surface water treatment and wholesale distribution system for the Santa Clara Valley. The Hetch Hetchy Aqueduct, owned by the City of San Francisco, brings water from the Yosemite area for consumption in several areas of Santa Clara County. The California Water Project's South Bay Aqueduct serves the SCWD with water from the Sacramento/San Joaquin Delta. A third aqueduct, under construction as part of the Federal Bureau of Reclamation's San Felipe project, will begin delivering water in 1988. This aqueduct will import water from the Sacramento Delta that is stored in the San Luis Reservoir.

Imported water is treated and distributed to municipal agencies and major water companies, who then distribute this water to users in the valley. The water retailers blend imported water with local ground water in many parts of the County, and with local surface water in some areas.

Water Treatment

Treatment of imported water includes coagulation, filtration, sedimentation, and disinfection through chlorination and chloramination. Local surface water and some ground water is also chlorinated. Hetch Hetchy water used in Santa Clara Valley is treated at four facilities between Yosemite and the valley prior to distribution to water purveyors. The SCWD treats its South Bay Aqueduct water in two large treatment plants in the valley, and is planning to construct a third plant to treat imports from the San Felipe project. The San Jose Water Company treats local surface water at three small plants.

In contrast to surface water supplies, most ground water used for drinking in the valley is not treated prior to use. Only 29 of about 300 major public water supply wells in the valley are chlorinated; 12 of these wells are also fluoridated. The San Jose Water Company chlorinates water from 9 of its approximately 150 ground water wells. The City of San Jose chlorinates groundwater from 3 wells in the Evergreen area. In South County, Morgan Hill chlorinates water from 10 wells and Gilroy from 7.

Sources and Uses of Water in 1981 - 1982

Figure 3 presents a schematic of water supply, treatment, and use in the Santa Clara subbasin for 1981-82, the most recent year for which data have been assembled. This was an unusually wet year, when the amount of water in storage in reservoirs and in the aquifer increased significantly. About 280,000 acre feet of water were consumed for non-agricultural purposes, half of which was pumped from the ground water subbasin. Most of the rest was treated imported surface water. Only 15,000 acre feet of local surface water were used. The Santa Clara subbasin is the only one in the valley for which accurate information is available. Water use in South County is estimated, since there are no meters to measure volumes.

About 230,000 acre feet of water recharged the basin that year, less than 10 percent of which was artificially recharged imported water. In an average year about 40 percent of all ground water recharge comes naturally from rainfall; another 40 percent comes from percolation of local reservoir water in stream beds and percolation ponds; and 20 percent comes from recharge of water imported via the South Bay Aqueduct.

Sources of Drinking Water by Service Area

About 1,500 drinking water wells are operating in the Santa Clara and Coyote subbasin areas, where ground water supplies are managed by the Santa Clara Valley Water District. About 4,000 wells exist in the southern part of the valley, an unknown number of which are inactive. A substantial number of wells throughout the valley are shallow (less than 100 feet), and serve only one or two households or commercial facilities; other wells are much deeper (especially in the North County) and serve hundreds to thousands of households. In many cases, water from several wells is blended; in the North County well water is often blended with surface water prior to distribution.

All wells which serve five or more households or facilities through a system of pipes, or which serve 25 or more nonresidents, 60 or more days a year (e.g., wells at hospitals, restaurants, industrial facilities) are regulated as integral parts of a "public water system" under the California Safe Drinking Water Act. This Act establishes regulations regarding construction, operations and maintenance, water quality monitoring, and notification of users of public water systems when water quality problems arise. California also has authority to enforce the federal Safe Drinking Water Act. The California Department of Health Services (DOHS) enforces the state and federal acts for those large public water supply systems with 200 or more service connections.

The Santa Clara County Public Health Department regulates public water systems in the county with fewer than 200 service connections. There are over 200 small systems in the county. Both large and small public water supply systems are subject to all federal and state drinking water standards. While the county's health agency enforces the same laws as DOHS, the state regulations require more extensive and frequent monitoring of water quality.

"Private" water systems (1 to 4 connections, and service to fewer than 25 nonresidents) are essentially unregulated. There are no monitoring requirements for such wells, and some private wells may now be in service despite contamination by bacteria or nitrates. A county ordinance is now being drafted that would extend some regulatory provisions to new systems with two to four service connections.

About 300 wells pump into 16 large public systems in the Santa Clara Valley. (There are 5 other large public systems that do not use ground water.) These wells account for about 86 percent of the ground water used in the Santa Clara and Coyote subbasins for non-agricultural purposes, and for about 3 percent of the ground water used for agricultural in the same area. There are also about 1,200 active small public system wells and private wells in this part of the valley, and about 4,000 active and inactive wells in the South County (the Llaga subbasin, from Morgan Hill south). Figure 4 shows the locations of about 250 non-agricultural wells in the North County that yield 17

acre feet or more of water per year. Wells with this yield would each be able to serve about 75 households. Some additional private wells are probably operating in the North County without complying with local registration and pump tax requirements. Table One presents available information on water production from these various sets of wells.

Figure 5 identifies the areas served by eleven municipal agencies and eight major privately-owned water companies that distribute water to users in the Santa Clara Valley. (Moffett Field and Stanford University also operate separate water systems, using Hetch Hetchy water.) Figure 6 provides additional detail on service zones within the San Jose Water Company's system, the largest in the county. These purveyors and zones provide different blends of local or imported surface water and well water to their customers.

Table 2 provides information on each of these major water purveyors, including the number of wells operated; summary information on depths at which water is collected; and the extent to which each purveyor relied on particular water sources in 1983. Six systems rely entirely on ground water: the Great Oaks Water Company; the Cities of Gilroy and Morgan Hill; and the Carribbee, Magic Sands, and Rancho Santa Teresa Mobile Home Parks. Four systems use imported water exclusively under normal conditions, and maintain standby wells: Palo Alto, Purissima Hills, Milpitas, and Stanford University. The cities of Cupertino, San Jose, Mountain View, Sunnyvale, and Santa Clara, and the California Water Service Company, use a combination of ground water and imported surface water. These systems operate from two to 150 wells each. The San Jose Water Company uses a mix of ground water, treated local surface water, and treated water imported by the SCVWD. The Redwood Mutual Water Company uses ground water and local surface water.

In areas not served by the major purveyors, small systems provide for domestic uses with ground water, surface water, or purchased imported water. Over 200 small systems exist in the northern valley; 71 provide water to residences. The others supply hotels, restaurants, businesses, nursing homes, schools, hospitals, parks, and so on. 44 of the 71 residential systems use ground water; these 44 systems have 1,466 hook ups.

In the southern parts of the county, surface water supplies are usually not available, and private wells are common. Some households in other parts of the valley, particularly in older subdivisions in Palo Alto and Mountain View, also use private wells for drinking. While water supply mains serve these areas, hook-up charges and higher costs for water may discourage residents with available private wells from connecting to the system. Some water purveyors are beginning to offer extended payment terms for those residents who close their private wells and switch to the public supply system.

Some private wells are connected into larger water supply systems so that well owners can either use their own wells or (in dry seasons) can purchase water. All large systems have cross-connection control programs to prevent possible backflow contamination from these interconnections. These devices can fail, however, allowing contamination from a shallow aquifer tapped by a private well to enter the main distribution system. According to DOES, this situation is unlikely to occur. Private wells are not known to be connected to small systems.

Monitoring Practices

The drinking water quality monitoring requirements applicable to all public water systems are based on EPA's Interim Primary Drinking Water Standards, adopted in the California Drinking Water Standards, California Administrative Code, Title 22. A summary of the required analyses is presented in Table 3. Drinking water monitoring practices in the area, however, are less uniform than this table suggests: some purveyors are required to do more monitoring because of special concerns (e.g., high nitrate levels), and some do more monitoring than is required. Practices have been changing significantly in recent years, and are likely to continue changing in the future.

The law requires that all public water supplies be monitored at prescribed frequencies for general mineral and physical characteristics, inorganic chemicals, and radioactivity. Surface waters are typically monitored at a higher frequency than ground waters; and surface water monitoring must also include a short list of organic chemicals for which Maximum Contaminant Levels have been established. (This list includes six pesticides.) Quarterly trihalomethane monitoring is required of all chlorinated systems serving more than 10,000 people.

Maximum Contaminant Levels (MCL's) are drinking water standards set by EPA and enforced by state agencies in California. Relatively few substances have MCL standards. States can set limits for MCL pollutants more stringent than those of EPA, or can set MCL's for additional substances; this has occurred in California for some pollutants. In addition, the state sets "action levels" for a larger list of pollutants. Action levels are triggers for state involvement in potential water quality problems, rather than formal drinking water standards that must be met throughout the state.

The Safe Drinking Water Act does not require that wells and other protected ground waters (i.e., springs) be monitored on a periodic basis to detect pesticides, or that surface water or ground water be monitored on a periodic basis to detect the kinds of organic chemicals used and stored at industrial facilities in the area. Nevertheless, extensive monitoring of this kind has occurred in the valley.

In 1980, the State Department of Health Services (DOHS) conducted a survey of water quality in four groundwater basins in California. 183 high yield wells in the Santa Clara Valley were tested for possible trichloroethylene (TCE) and perchloroethylene (PCE) contamination as part of this study, and no ground water contamination was found in these wells. However, the samples collected from several wells (including Great Oaks Well #13) were lost or tested improperly due to lab errors. No efforts to resample were made as part of this one-time multi-basin screen.

In late 1981, a leaking underground waste solvent storage tank was discovered at the Fairchild Camera and Instrument Company's facility in south San Jose. Great Oaks Well #13 was in the path of the contaminant plume from that tank; the well was checked and found to be contaminated with 1,1,1-trichloroethane (TCA) at levels of about 5,800 ppb—roughly 30 times higher than the published state Action Level of 200 ppb. (No formal drinking water standard exists for this contaminant.) The well was removed from service. This discovery prompted an additional survey of large public water supply wells in the Santa Clara

Valley. DORS, the Santa Clara Valley Water District (SCVWD), retail water agencies, and the Santa Clara County Department of Public Health worked together on a survey of 112 major production wells in early 1982, covering 114 organic chemicals from EPA's priority pollutant list. Analyses were conducted to detect volatile organic compounds (VOC's), base neutral/acid extractable organics, pesticides, and PCBs. An additional 16 wells were tested for VOC's only. Most of the large water systems, along with several small water systems, were tested under this program. Results from this survey did not show any contamination, except for that already known at Great Oaks Well #13.

Following the 1982 survey, the water purveyors in the valley adopted an ongoing program under which each water system assumed responsibility for its own monitoring. The purveyors agreed voluntarily to monitor all wells at least once every three years, and to monitor wells near known contamination sites more frequently. Sampling was to include testing for volatile organic compounds, plus additional chemicals known to be used in the area. Some wells have been retested for organics since 1982 under this voluntary monitoring program, and other wells were retested during investigations of known contamination incidents. Tests of some wells in the vicinity of contaminated zones now occur with frequencies ranging from annually to monthly.

Implementation of Assembly Bill 1803, now in progress, will affect monitoring practices. Under the bill, the State Department of Health Services can require a special one-time screen at any water system where it determines that a risk of contamination exists, and can subsequently set monitoring requirements tailored to the needs for monitoring of that system. In the Santa Clara Valley, implementation of A.B. 1803 will result in another comprehensive round of screening, and in some additional mandatory periodic monitoring for organics in most large public water supply systems. A.B. 1803 also requires the State Department of Health Services to submit a plan for screening small public systems by January, 1986. Under the act, monitoring as frequently as quarterly can be required on a continuous basis where DORS determines this is needed.

A.B. 1803 requires DORS to advise large public water supply systems if their water is at risk for particular contaminants, and to review and approve the monitoring plans submitted by purveyors to assess potential contamination. This process is now nearing completion in the Santa Clara Valley, and testing has begun. Tests will address VOC's in all cases, some base neutral and acid extractable organics in industrial areas, and pesticides in agricultural areas. Although water purveyors can propose to test only representative wells under A.B. 1803, some water purveyors in the Santa Clara Valley are testing all of their wells. Some purveyors will have additional monitoring results by the time this White Paper is released; and all the major purveyors should have new results by early 1985. Table 5 provides details.

Early rounds of monitoring under A.B. 1803 are revealing some contamination that was previously unknown. Four standby wells in the San Jose Water Company system showed TCA at levels ranging from 2 to 28 ppb. (The state action level is 200 ppb.) One of these wells also showed 0.8 ppb of 1,1-dichloroethylene. (The state action level is set at the detection limit of 0.1 to 0.4 ppb.) Another San Jose Water Company well showed 1 ppb of PCE. (No state action level has been published.) The most significant discovery to date from A.B. 1803 monitoring involves a well in Los Altos that is contaminated by carbon tetrachloride. When this well was tested in 1980, no contamination

was detected. Carbon tetrachloride levels have risen since contamination was detected, and now are roughly at the state action level of 5 ppb. This well is out of service. Neither the source of this contamination nor the depth of the contaminated zone in this non-industrial area have been determined, and investigation is continuing.

Table 4 lists the action levels which DOHS has published for some substances; DOHS uses unpublished thresholds for some other substances. In almost all cases, these substances can be detected at much lower concentrations than the established action limits, so that substances can be detected at levels which do not violate violating Maximum Contamination Levels or exceed state action levels.

Private wells are not subject to monitoring requirements and are typically tested only during investigations of specific contamination incidents. Such tests may be done by those responsible for the contaminant release, by the County Public Health Department, or by DOHS. The County Public Health Department can require monitoring or closure of private wells where an imminent danger to health exists.

DRINKING WATER QUALITY AND CONTAMINATION ISSUES

Some drinking water problems exist in the Santa Clara Valley. Nitrate levels in South County ground water have been high for many years. Very high levels of bacterial contamination have been found in some private wells. TFM's at or near established standards have been measured in treated imported surface water periodically. Salt water intrusion has made some shallow zones near the bay unsuitable for drinking water; some salt water has travelled through "conduit wells" to the deep aquifer as well. South Bay Aqueduct water is susceptible to pesticide contamination in the Sacramento/San Joaquin Delta area. While some contamination has been detected in Delta Water used for the aqueduct, no pesticides have been found in water entering the SCVWD treatment plants.

These kinds of problems are not unique to the Santa Clara Valley. As a result, the technical issues involved in addressing these water quality issues are well understood. State and local agencies have studied these problems, have taken some actions to address them, and are planning additional action.

Leaks and spills of toxic organic chemicals stored or handled at industrial facilities have contaminated 16 wells connected to large public water supply systems and 43 private drinking water wells in the Santa Clara Valley. (Two other public wells have been contaminated, but sources have not yet been established.) Purveyors closed some of these wells; others have remained in service with contamination levels well below state Action Levels.

The next subsection of this paper discusses contamination from industrial sources. This is followed by discussions of other potential drinking water issues.

Various organizations in government and industry are taking steps to identify contamination sites, to assess the extent and levels of contamination at particular sites, to act immediately in the most urgent cases, to prevent future spills, and to keep contaminants now in soils and groundwater from affecting drinking water supplies. These activities are discussed beginning on page 23 of this paper.

Ground Water Contamination from Industrial Sites and Gasoline Storage

Known Industrial Contamination Sites

The problem of toxic organics leaking from underground tanks and sumps at industrial facilities in the Santa Clara Valley, or spilled at these sites, emerged in late 1981 when a leak was discovered in an underground storage tank at Fairchild Camera and Instrument Company in south San Jose. Subsequent study of inventory and disposal records indicated that about 60,000 gallons of waste solvent had been released over at least 18 months. When the leak was discovered, the Great Oaks Water Company's well #13, serving about 700 people, was found to be contaminated with 1,1,1-trichloroethane (TCA) at about 5,800 ppb. (The state action level for TCA is 200 ppb.) This well was immediately removed from service, and in later testing showed TCA levels as high as 8,800 ppb. (Contaminant concentrations in this well today are about 60 ppb.)

Investigations by other firms revealed 21 other leaks and spills in the valley in the winter of 1981-1982. Since then, 71 other sites have been identified as contaminated, largely as the result of an underground tank leak detection study by the Regional Water Quality Control Board. (This study examined tank sites and found contamination in other parts of the Bay Area as well.) The RWQCB now lists 93 contamination sites exist in the Santa Clara Valley. At many contaminated sites, tank failures were eliminated as a cause of contamination, suggesting that some—perhaps many—of these contamination incidents are due to causes such as spills or small discharges onto the ground during handling operations.

Levels of contamination found in the soil and ground water at contamination sites vary widely. The stages that sites have reached in assessing contamination or in planning or undertaking clean up efforts also vary.

Table 6 lists the known contamination sites in the county. Many of the sites on this table are numbered; the locations of numbered sites are shown on the map provided as Figure 6. Table 6 also provides information on the status of site investigation and clean up activities, and on whether drinking water wells have been affected.

Table 7 reports data on the levels of contaminants found in soil and ground water at some of these sites. The table is based primarily on data collected in an initial screen of these sites, and is not an up-to-date and comprehensive summary of data in state agency files. The data provide an indication of contamination levels, but at some sites may not be representative of the general situation at the site. In addition, the risks posed by contamination at a site depend on its geological setting, and on actual use of ground water in the vicinity of the site. Therefore, the data in Table 7 should not be used to compare sites to one another.

Five contamination incidents have affected a total of 62 drinking water wells in the valley, including 19 wells in large public systems and 43 private wells. Water purveyors have responded by closing wells with detectable organics, with some exceptions where concentration levels are below State action levels. Table 8 provides details on these wells. To date, all wells known to have been affected by spills or leaks are either in the recharge zone, or in the shallow aquifer above the confining layer in the confined zone. No wells in the deep confined aquifer are known to have been affected.

Contamination from the Fairchild plume in south San Jose has led to the closure of one of the Great Oaks Water Company's wells; Great Oaks' policy is to take a well out of service if there is any detectable contamination. Contamination at the IBM site, also in South San Jose, has affected 8 San Jose Water Company wells (including 4 standby wells), 3 City of San Jose wells, 2 Great Oaks' wells, 1 Magic Sands Mobile Home Park well, 2 Rancho Santa Teresa Mobile Home Park wells, and 8 private or small system wells. The Great Oaks wells and three private wells have been shut down; the other wells remain in service (or on standby) with very low levels of contamination. All of these wells draw from the recharge zone.

Contamination originating at least in part from the Teledyne Semiconductor site in Mountain View contributed to the closure of 35 private wells in an area extending from Terra Bella Avenue northward to Charleston Road. All of

the contaminated wells draw from shallow aquifers in the area; wells deeper than 60 feet were not affected. Municipal wells in this area draw from the deep confined aquifer, which is separated from the contaminated shallow aquifers by a thick clay layer. These wells have not been contaminated.

The shallow wells tested during investigation of this contaminant plume also showed bacterial contamination, in some cases at levels hundreds of times higher than Maximum Contaminant Levels established for public water supply systems. This bacterial contamination probably originated from septic tanks.

Five other sites in Palo Alto and Mountain View have affected one private well each; these sites are listed in Table 6.

Known Contamination from Gasoline Storage

Underground storage of gasoline at service stations, industrial facilities, and farms is common in the Santa Clara Valley, as in the rest of the United States. Most older gasoline tanks are single-walled steel vessels, with no corrosion protection. The risk that these tanks will fail due to corrosion increases with tank age; the average age of steel tanks that have failed is about 15 years. Many tanks in the Santa Clara Valley are approaching this age. Some oil companies have been systematically replacing older steel tanks in the Santa Clara Valley and elsewhere in the country.

Some releases from gasoline storage facilities are known to have occurred. Two years ago, massive releases of 300,000 gallons and 100,000 gallons occurred at tank farms in San Jose. Since then, about 30 additional leaks of 100 to 10,000 gallons each have occurred at service stations in San Jose. Many of these leaks are due to pipe failures rather than tank failures.

The Sunnyvale fire department expects to discover additional leaks as monitoring results at other stations are reported. In Sunnyvale, 11 leaks have been discovered so far among about 50 stations in the city. The average loss from these leaks has been about 3,000 gallons. Tanks have been replaced at six sites. Leaks in pipes have been repaired at other sites, and some stations have closed.

Gasoline has also been found floating on the surface of the shallow ground water near Pear Avenue in Mountain View. The cause and extent of this contamination is under investigation by the RWQCB.

In the past, gasoline leaks were usually found by owners who noticed a shortage in their inventory. These leaks have come to the attention of authorities through self reporting, or when permits are sought to drill monitoring wells or to make repairs. It is virtually certain that some gasoline leaks are not detected by facility owners, and are not reported to the authorities. The BMD's, discussed below, should improve leak detection.

In some cases, the characteristic taste and odor of gasoline will indicate that drinking water has been contaminated. However, the constituents of gasoline can separate in ground water, and exposure to some constituents can occur without taste and odor indicators being present. Clean ups at gasoline sites in which the RWQCB has been involved always require the removal of floating product, and sometimes address dissolved constituents of gasoline as well.

The Potential for Discovery of Additional Contamination Sites

Evaluation of tank sites in the valley is incomplete. The RWQCB recently sent questionnaires to 2,644 facilities in the area that might have underground tanks or sumps, and had received about 1,859 responses by mid-1984. This survey excluded gasoline stations.

Respondents reported 1,692 tanks or sumps at 388 facilities; 90 percent of these responses came from facilities in the Santa Clara Valley. Subsurface assessment were made at 96 sites which stored or handled solvents at concentration of greater than one percent in underground tanks or sumps. The RWQCB selected solvent sites for evaluation because of the toxicity, persistence, and mobility of solvents in groundwater. In addition, the investigation of solvent tanks was manageable given the RWQCB's resource constraints.

Contamination was found at 75 of the 96 sites examined, but these sites represent less than a third of the identified industrial sites with underground tanks and sumps. Approximately twice as many tanks per site exist at sites that were not assessed as at sites that were assessed. In addition, tanks at non-solvent sites were, on the average, somewhat older than tanks at solvent sites.

Housekeeping practices may differ for nonsolvent industrial tanks, but unless housekeeping differences are significant it seems likely that at least the same proportion of non-solvent as solvent sites are contaminated. This would imply that about 200 more contamination sites may exist in the Santa Clara Valley, even before considering service stations and the 745 facilities in the Bay Area that have not responded to the RWQCB's questionnaire by mid summer.

The RWQCB intends to investigate other potential sources of contamination when resources permit. In addition, monitoring under local Hazardous Materials Management Ordinances (HMMO's) and parallel State legislation should identify additional contamination sites.

Measures to Address Tank Site Releases

Due to a combination of natural processes and corrective action, contaminant releases in the valley have seldom resulted in drinking water contamination. Leaks and spills at industrial sites are initially local phenomena, with effects that can be isolated and controlled. In addition, a great deal is now being done to prevent future releases of hazardous materials into ground water. The next few pages discuss various processes and programs that help to control risks from tank sites.

Natural Protections

Natural processes provide wells with some protection from contaminants released near the land surface. These processes are explained more fully in Appendix A, and applied to the local hydrogeology in Appendix B.

The most important natural feature protecting drinking water is the thick clay layer separating the upper and lower aquifers in the confined zone. (The approximate boundaries of this zone are shown in Figure 1.) Public water supply wells in the confined zone generally draw water from the lower aquifer, and the confining layer acts as a substantial barrier to contaminant migration into that aquifer from upper zones.

The confining layer does not provide complete protection from contamination. This layer may leak in some areas, and it is pierced by wells that may act as conduits for contamination; in addition, contaminants may migrate into the deep aquifer from the recharge zone. But a substantial amount of natural protection exists. Despite a large number of known contamination sites in the confined zone (see Figure 6), and extensive monitoring of the deep wells in the area, no wells drawing from the deep confined aquifer are known to be contaminated.

The threat of drinking water contamination in the confined zone is greatest when spills occur near shallow private wells (as occurred in Mountain View) or near conduit wells connecting the upper and lower aquifers.

Similar but less extensive clay layers below the surface provide some protection from contaminant migration in other parts of the Santa Clara Valley. However, these lesser aquacludes are discontinuous, and cones of depression around major wells readily draw contaminants toward the wells. The IBM and Fairchild plumes both have affected relatively deep wells in the recharge zone.

Contaminant concentrations in ground water will also decrease as contaminants move from a release site to a well. Dispersion of contaminants into a greater volume of water is a major cause of this reduction in concentrations, but contaminants can also degrade or adhere to soils. Typically, the combination of these processes will result in significant reduction in concentrations with distance travelled. Ground water clean up activity can reinforce this effect. By January 1983, contaminant concentrations in the path of the plume about one mile from the Fairchild spill were 10,000 times lower than concentrations at the site.

Well Sealing

Contaminants can migrate between zones separated by aquacludes through inactive and abandoned wells. Any well that connected different subsurface zones when constructed can act as a conduit if it is not being pumped continuously. Abandoned wells can also corrode and connect zones which had been isolated from one another. Wells can be sealed to isolate different subsurface zones from one another. Great Oaks Well #13, in the Fairchild plume, is believed to have acted as a conduit to carry contamination to deeper zones. There is also evidence that wells in the confined zone have allowed transport of salt water into the deep aquifer. However, there are no documented cases of contaminant transport through wells to the deep confined aquifer.

There may be as many as 10,000 inactive and abandoned wells in the Santa Clara Valley. This is a very rough estimate. Available records on wells are incomplete: well drillers have been required to submit drilling logs to the

State since the 1950's, but many wells were drilled (prior to and after this requirement) without logs being filed. Since 1975, wells in the Santa Clara Valley have been subject to ground water withdrawal charges, and permits have been required to close wells or to build new wells, so that wells abandoned since 1975 should be on record. However, compliance with these requirements is probably imperfect, and many wells were abandoned prior to 1975.

Some wells can also be located by examining old aerial photographs of the area, or by looking for surface physical traces. EPA and the SCVWD are reviewing photographs, but all surface traces of many wells have been eliminated during subsequent land development activity. In many cases, old well casings have simply been cut off or capped below the land surface, and covered by new construction.

The most important abandoned wells are deep wells in the confined zone that penetrate the confining clay layers. Where penetration of a confining layer is not an issue, deeper wells will generally be more important than shallow wells, because they can have more of an effect on how contaminants spread.

The SCVWD has identified 1,100 wells as candidates for sealing, and is continuing its well identification efforts. The District has also begun a program to seal wells with relatively high potential to act as conduits for contaminants. Approximately \$800,000 has been set aside for an initial effort directed toward closure of 200 or more wells. The SCVWD sent letters offering free well closures to the owners of 150 wells that are in or near contaminated zones and at least 150 feet deep. In response to this initial contact, some well owners declined the offer of closure of their inactive wells. The SCVWD is now working with local governments to persuade owners to consent to closure.

The Hazardous Materials Management Ordinance

Local government officials in the Santa Clara Valley have moved aggressively to find hazardous materials spills and to prevent future spills. The discovery of contamination at industrial storage sites led to a cooperative effort to develop a new model Hazardous Materials Management Ordinance (HMMO), which became effective in most parts of the Valley in July 1983. City and county officials (including fire department officials with jurisdiction over hazardous materials storage) led this effort, which also included state agencies, industry, and environmental groups.

The model ordinance requires industry to include a secondary containment system (a second tank wall, or a lined vault for the tank to catch leaks) in all new storage facilities, and to monitor between containment systems. Existing facilities are required to monitor to detect any contaminant releases. All facilities must submit plans for managing their hazardous materials, report suspected releases, and clean up contaminants if a release occurs.

After these local ordinances were in place, A.B. 1362 was enacted to address the same issues throughout California. This state law will probably play some role in shaping implementation of the local ordinances, because local programs must be as stringent as the state program.

The HMMO's have various compliance deadlines. Provisions applicable to new facilities became fully effective in July 1983. Existing facilities were required to submit inventory data in late 1983, and to follow that basic information with plans for complying with the substantive requirements of the ordinance, including monitoring requirements. Local jurisdictions must respond to those plans, and facilities have six months to implement monitoring once a plan has been approved. Local officials expect that most facilities will have monitoring systems in place by the end of 1985. In some jurisdictions, tank sites will be inspected when monitoring is in place. In addition, local officials have agreed on a uniform spill and leak reporting form for use throughout the region.

Some early plan submissions showed a need for guidance on acceptable means for complying with the ordinance, and local governments have provided such guidance from time to time. Many cities have adopted guidance suggested by the SCVWD. In most cases, this guidance makes it clear that the monitoring requirements of the ordinance can be met only through measures that approach continuous testing for releases of contaminants. This could take the form of frequent and sensitive tank testing, but more than 98% of all plans for existing underground tanks submitted to the City of San Jose have proposed a monitoring system using monitoring wells. Typically, these wells will be sampled monthly.

The HMMO's will lead to safer new storage facilities. Monitoring well installation at existing sites will probably also lead to the discovery of additional contamination sites, which can then be cleaned up. However, no systematic program is in place yet to assure that detected contamination is always reported. The monitoring requirements under the ordinances make it much more likely that any leaks will be detected soon after they occur, allowing additional time for remedial action to protect drinking water supplies. However, the reliability of monitoring wells will depend to significant degree on proper well placement, and there have been cases in the past when wells have failed to detect confirmed leaks. In most cases, monitoring is likely to be supplemented by tank testing; the goal under the HMMO's is to use tests that can detect leaks of 0.05 gallons per hour or more.

Clean-up Efforts

When contaminants are released, corrective measures are an important supplement to the natural features that help protect drinking water. These measures can take several forms. Contaminated soils can be removed from the site. Once the plume of contamination has been defined, wells can be drilled into the plume and pumped to remove contaminated water from the aquifer. When properly implemented, pumping programs both prevent contamination from spreading, and reduce the mass of contaminants in the ground water.

Companies in the Santa Clara Valley generally are cooperating with regulatory agencies to remedy the contamination problems that have been identified in the Santa Clara Valley. Since 1981, industry has spent an estimated \$50 to \$70 million dollars to characterize and clean up contamination and to upgrade hazardous materials storage practices. As of September 1984 problem characterization had begun at about 90 sites in Santa Clara County. Contaminated soil removal had begun at at least 15 sites, and and pumping to contain contamination and clean up ground water at six of these sites and nine additional sites.

Efforts to define the problem and to implement effective clean up measures are still in the early stages at many sites. Table 6 provides details on assessment and clean up efforts at each site.

The ground water clean up efforts that are underway in the valley are among the most extensive in the U.S. About 16 million gallons of ground water per day are pumped at the Fairchild and IBM sites, both to prevent contaminant migration and to remove contaminants from the aquifer. Contaminated water is being treated by aeration prior to discharge; less contaminated water is being discharged under a permit directly to storm sewers and local creeks. During surface transport of this water toward the bay, aeration allows contaminants to volatilize from water into the air. The air quality aspects of this program have been reviewed and approved by the Bay Area Air Quality Management District and the State Department of Health Services.

Pumping programs use up ground water, and in parts of the country where ground water is scarce such programs need to be carefully calibrated to minimize water use, and the effects that cones of depression from extraction wells can have on nearby wells. Pumping to control and clean up the the IBM and Fairchild plumes has not inhibited the Great Oaks Water Company's ability to install a new water supply well in the area. However, these pumping programs are very intensive, and account for about 10 percent of all ground water withdrawal from the Santa Clara subbasin for a typical year. Moreover, these withdrawals offset about half the recharge of imported surface water to the subbasin in a typical year. IBM and Fairchild pay ground water extraction charges in connection with these programs.

A few major ground water contamination incidents are more easily handled than a great many such incidents, because replacement water supplies are more readily available and because less ground water is used in clean up activity.

Site clean-ups can be carried to various degrees of completeness, but it is often technically infeasible to reduce contaminant levels to zero or to background levels. Clean up levels for sites in the Santa Clara Valley will be set by the RWQCB and DOHS, with EPA participation. Clean up levels may vary at different sites, depending on the risks posed by contamination at those sites.

Treatment and Alternative Water Supplies

Many of the contaminants discovered at Santa Clara County's industrial sites could also be removed from drinking water by treatment processes, either at the public well head or elsewhere in the water supply system. Treatment has not been used in this way in the Santa Clara Valley; protection has been provided through other means.

Wells drawing on contaminated groundwater can also be closed to prevent population exposure to hazardous constituents, and replacement water supplies provided from other wells or local surface water where alternate sources of water are available. The Great Oaks Water Company initially replaced the supplies it lost through well closures by purchasing water from the San Jose Water Company, but has since installed a replacement well. This well required a permit from the State DOHS, as do all all public water supply wells for large systems. In connection with that permit, DOHS carefully reviewed plans for the

well to assure that the well would be outside the area affected by contamination. The effects of pumping stresses from this well on contaminant migration are being monitored by testing wells installed between the plume and the new water supply well.

PCB-Contaminated Soils

Use of polychlorinated biphenyls (PCB's) as a weed killer along the property line of the Westinghouse plant in Sunnyvale more than 20 years ago resulted in contaminated soils in neighbors' yards. Some soil samples have shown contaminant levels almost 10,000 times higher than the state limit of 2 parts per million. This contamination was discovered and reported by Westinghouse in 1981, and clean up options have been under review since then. RWQCB issued a clean up and abatement order in September 1984. No other similar sites are known to exist in the valley.

Trihalomethanes

Trihalomethanes (THM's) can be formed when chlorine used to disinfect surface water reacts with organic material in that water. THM levels vary with incoming water quality. Chlorination is the standard form of disinfection for drinking water in the U.S., and without proper disinfection overall health risks from pathogens could be far greater than risks from THM's.

Chloroform (one component of THM's) is a suspected carcinogen. Other components of THM's, in which bromine atoms are substituted for chlorine atoms, are thought by some toxicologists to be more potent carcinogens than chloroform. EPA has established a running annual average maximum concentration limit of 100 ppb for total THM's. THM levels within a system vary with residence time after chlorination, and are typically higher around the edges of a water distribution system than near the treatment plant. The rules for determining compliance with THM standards require that 25% of the samples averaged be taken at the far ends of the distribution system, with the remaining 75% of samples spread throughout the system.

THM levels below 100 ppb cannot always be attained when surface water supplies are disinfected with chlorine. When SCVWD first monitored treated water from its new Rinconada plant in 1981, annual average THM levels reached 106 ppb. The SCVWD acted to reduce THM levels by changing its treatment process at Rinconada to chloramination, a treatment process that combines chlorine with ammonia. Trihalomethane levels can be substantially reduced by using this process. Necessary equipment is now in place at Rinconada, and adjustments and operating procedures are being worked out. When the system is in use, THM levels have been reduced to 15 to 20 ppb, but there are still serious operational problems. At times, the SCVWD must still use full chlorination to control taste and odor problems.

Table 8 provides data on average THM levels in treated imported surface water in the Santa Clara Valley for more recent periods. The overall effectiveness of the new process at Rinconada in reducing average THM levels is evident in Table 8, which also shows that other treated surface water in the valley now generally meets standards. Treated Hetch Hetchy and Penitencia treatment plant water typically shows THM levels in the range of 50 to 70 ppb.

Chloramination costs a few dollars per acre foot more than straight chlorination. Other more expensive drinking water treatment alternatives also exist, and can reduce THM levels to even lower levels. For example, THM levels can be reduced to a few ppb by using ozone-based treatment processes, and the SCVWD is examining this kind of process. However, ozonation is quite expensive (up to three times the cost of chlorination), and can result in additional air pollution from ozone manufacture. Unlike chlorination, ozonation does not provide residual disinfecting protection within the distribution system. The process is uncommon in the United States.

Nitrates

A maximum concentration limit of 45 milligrams per liter (mg/l, or ppm) of nitrates (as NO_3) has been established by EPA to protect infants under six months of age from methemoglobinemia ("blue baby" syndrome). No other acute or chronic health effects are known to be attributable to nitrates at levels below this standard. Some otherwise harmless bacteria can transform nitrate into nitrite, which may have chronic health effects. Only very low levels of nitrite have been found in Santa Clara Valley wells, but there has been little monitoring for nitrites in the South County.

The 45 mg/l standard is often approached or exceeded in South County wells. Nitrate levels approaching this standard have also occasionally been observed in some North County wells, but levels in these wells have not exceeded the standard and have not been persistent. No cases of methemoglobinemia are known to have occurred as a result of ingestion of high-nitrate water in the Santa Clara Valley.

An average nitrate level of 40 mg/l was found in wells tested in the San Martin area in 1978 and 1981, with one-third of the tested wells showing nitrate levels in excess of the standard. In late 1981, the Santa Clara County Department of Public Health and the State Department of Health Services began a joint effort to monitor nitrate levels in 30 small system and private wells in San Martin, Morgan Hill, and Gilroy on a monthly basis. Monitoring continued for 18 months, and was supplemented by spot monitoring of other wells. Nine of the 30 wells monitored on an ongoing basis showed nitrates in excess of the standard on a consistent basis, and another 3 wells showed occasional violations. Summary data on these 30 wells is provided in Table 8.

The City of Morgan Hill also operates a water supply system that has violated nitrate standards since 1979. This system continues to operate because no alternative source of supply is immediately available; as a condition of continued operation, the city is required to provide continuous notification to the public using its water that the water is not fit for use by infants. DOHS has required the city to reach compliance with standards by 1988, either by securing a new source of water or by treating water from its wells. The City of Gilroy has also had excessive levels of nitrates in several wells. Those wells with levels exceeding 45 mg/l have been removed from service.

High nitrate levels typically occur in unsewered and agricultural areas with shallow groundwater tables. Nitrates are released by septic tanks and can leach from fertilized fields, lawns, or orchards. In a fertilized and heavily irrigated area, up to 30 percent of the nitrates in fertilizer applied may leach from the field, and water in irrigated fields can percolate downward

20 to 30 feet in a year. High nitrate levels are also associated with accumulations of waste organic matter, as at the numerous mushroom farms, animal feed-lots, poultry operations, and wine-making plants that are now being slowly displaced in the South County. Because nitrates degrade very slowly, past releases contribute to high nitrate levels in groundwater today.

In some parts of the South County it is difficult to find locations for new wells with low nitrate levels. Nitrate contamination is extensive throughout the area, and past well construction practices have mixed nitrates into deep ground water zones.

The short term solution to high nitrate levels is to prevent use of high nitrate water by infants by closing wells, notifying users, or treating contaminated water. As discussed above, Gilroy has closed wells and Morgan Hill is temporarily relying on a notification program. The San Ysidro Elementary School in Gilroy, which consistently shows about double the allowable level of nitrates in its untreated well water, is treating this water by reverse osmosis to reduce nitrate levels. Notification programs and related publicity have probably helped inform private well users of a potential problem, but some private well users may not know that their wells may contain high levels of nitrates.

The long term solution to high nitrate levels probably involves reduced nitrate loadings and increased recharge of the aquifers with imported surface water, or use of treated surface water from the San Felipe project as an alternative source of supply. If loadings can be controlled, the aquifer should be able over time to flush out existing nitrates; however, the pattern of monitoring results in recent years suggest that this approach is not working well yet. San Felipe water probably cannot be generally available in the South county for at least five to six years.

Salt Water Intrusion

Groundwater withdrawals from the shallow aquifer near San Francisco Bay have resulted in migration of salt water into inland areas, making parts of this aquifer unsuitable for drinking. Unexpectedly high levels of chlorides have also been found in the deep aquifer along Gualdalupe Creek and near Palo Alto, perhaps because salt water has been able to pass through the confining layer where improperly constructed or abandoned wells act as conduits, or due to natural gaps in the confining layers. Because simple chloride salts will make water taste bad before the salts themselves become dangerous, salt water intrusion is primarily a water supply issue.

Land surface subsidence caused by past overdrafts of ground water have resulted in deeper tidal penetration of salt water into creeks and sloughs than in the past. This condition is irreversible. However, salt water intrusion in groundwater can be reversed by changing hydraulic conditions. The higher water table levels created by increased aquifer recharge in the Santa Clara subbasin have returned the salt water intrusion boundary toward its mid-1960's location in the shallow aquifer. While this boundary may now be at an acceptable point, contamination of the deep aquifer remains a concern. The SCWWD's well sealing efforts, discussed earlier in this paper, are intended to address the salt water intrusion problem as well as the potential problem of industrial contaminant migration.

OTHER DRINKING WATER ISSUES

Bacterial Contamination and Septic Tanks

EPA has established a maximum contaminant level of one coliform bacterium per 100 milliliters for drinking water, and this limit is exceeded in some ground water in the valley. Chlorination is used to kill bacteria in 9 of the 150 San Jose Water Company wells, 3 City of San Jose/Evergreen system wells, 10 Morgan Hill wells, and 7 Gilroy wells. In addition, all public system water supply wells are tested weekly for bacterial contamination. Private wells are not tested on a regular basis, however.

As a result of contaminant releases at Teledyne Semiconductor, about 35 private wells in Mountain View were recently tested for industrial and bacterial contamination. In addition to contamination from industrial sources, these wells all had coliform counts in excess of the standard, and some of the wells were hundreds of times above the standard. Bacterial contamination has also been found in the Lake Canyon area of Los Gatos.

Septic tanks are commonly used in Los Altos Hills, in the unincorporated areas near Saratoga and Los Altos, and in the unincorporated South county areas. Wells will usually not be contaminated where both septic tanks and wells are properly constructed, located, and maintained. Bacterial contamination of private wells is most likely to occur when older septic tank systems are located near older shallow wells, which may lack adequate sanitary seals. This combination of conditions is found primarily in areas like Mountain View, where older relatively dense subdivisions overlie shallow ground water. Ground water tests conducted in connection with applications for new wells suggest that bacterial contamination is not a widespread problem in the County.

Septic tanks also contribute to other groundwater and drinking water problems. Even properly constructed and operating septic tank systems will leach some nitrates to groundwater, and in the drier parts of the South County septic tank leach fields account for a major fraction of total ground water recharge. Septic tanks can also be sources of toxic organic contaminants, if those contaminants are disposed of in drains or introduced into the system by their owners for maintenance purposes. Various toxic organic compounds—including some of the same chemicals used by industry in the valley, and found in contaminated drinking water wells—have been routinely used in the past for periodic septic tank maintenance. When introduced into a septic tank these chemicals can leach into the soil and groundwater.

Sewer Wells and Dry Wells

Sewer wells are wells used to carry septic tank effluent to deeper zones. Wells of this kind have been illegal since the 1950's in the Santa Clara Valley, but construction and use of such wells probably continues today. These wells raise the same contamination issues as septic tanks, but introduce those contaminants into deeper zones.

Dry wells are large diameter, relatively shallow (20 to 30 ft) wells used as sumps to collect runoff from developed land areas such as parking lots. These wells allow runoff to seep into and recharge the aquifer. The use of dry wells is required or encouraged in some parts of the County. However, dry wells will carry any contaminants in runoff into the aquifer.

Sewer Lines

Sewer lines, which typically leak, may also be a source of ground water contamination. During wet periods or where lines are buried in water bearing zones, additional water will leak into sewer pipes and increase the amount of waste water reaching treatment plants. These lines may release contaminants during dry periods, when groundwater levels are below the levels at which pipes are buried.

Sewer lines in the valley carry industrial waste water; these waste waters may contain low levels of some substances that are found at more concentrated levels in underground tanks. Sewers and storm drains may also be used for illegal disposal of hazardous materials.

There is no evidence that leakage of contaminants from sewer pipes is a health issue. However, EPA will examine this question further in the Integrated Environmental Management Project (IEMP).

Contaminant Infiltration to Water Supply Pipes

Studies in progress at Battelle Labs, Inc., have shown that pure solvents can permeate water pipes made of various materials, despite water pressure inside the pipe. Further studies are now underway to determine whether contaminants can enter water pipes buried in soils and exposed to contaminants diluted in ground water. EPA is following this research to assess its implications for the Santa Clara Valley, and for other regions. However, in the Santa Clara Valley the water mains for the major water systems do not run through the known boundaries of contamination plumes, and so are not believed to be subject to permeation.

Impoundments and Operating and Abandoned Landfills

Facilities for storing or disposing of wastes on the land are potential sources of groundwater contamination. Wastewater impoundments exist at a few industrial facilities in the Santa Clara Valley; there are also several landfills for municipal wastes.

Evidence has not been collected to indicate whether these facilities are causing a ground water contamination problem. EPA will assess potential risks from these facilities as part of the IEMP. Most operating landfills in the valley are located near the bay where releases of contaminants would be unlikely to affect drinking water. The ground water around these facilities is generally monitored by the facility operators.

Sewage Treatment Plant Effluent Discharges and Sludge Storage

Publicly Owned Treatment Works (sewage treatment plants, or POTW's) in North County store sludge on the land; in addition, the Gilroy POTW discharges waste water to percolation ponds south of the city. Sludge storage areas, such as the municipal landfills in the area, are located near the bay. Ground water under Gilroy's percolation ponds flows generally southward, away from the city. EPA will assess potential risks from these facilities as part of the IEMP.

Pesticides

Low levels of pesticide contamination have been detected in water in the Sacramento/San Joaquin Delta, including the water released into the South Bay Aqueduct at the Clifton Court Forebay. Additional monitoring in the Delta will soon be undertaken by the State Department of Water Resources; these tests will address a large number of pesticides and will be timed to match pesticide application activity. These tests should provide a more reliable indication of whether there is a significant pesticide contamination problem than past monitoring has provided.

Water in the South Bay Aqueduct is unlikely to be affected by pesticides while in transit to the Santa Clara Valley. Most of the aqueduct is covered between Clifton Court and the Santa Clara Valley, and there is little agriculture in those areas where the aqueduct is uncovered. No pesticide contamination has been detected during routine monitoring at the SCWWD treatment plants.

Use of pesticides in the Santa Clara Valley is also a potential source of drinking water contamination. There is no requirement for periodic monitoring of well water for pesticides; however, monitoring done in connection with the 1982 screen of major supply wells detected no pesticides. In addition, the state Department of Water Resources tested five wells in the valley for contamination by dibromochloropropane (DBCP), a relatively persistent pesticide that was in use in the valley. No contamination was found.

Pesticide contamination of ground water and of surface water runoff from local agricultural activity is common in some other parts of the state, where sandy soils are found. However, pesticides are generally strongly bound to richer soils, such as those found in much of the Santa Clara Valley. This bonding retards the transport of pesticides in ground water, sometimes so significantly that they are for practical purposes immobile. Furthermore, some pesticides may be degraded by sunlight, by the activity of natural microorganisms, or by natural chemical processes that take place in surface water and groundwater. Of course, the relative immobility and potential for degradation vary among pesticides, as well as with the environmental conditions (e.g., soil type, temperature, etc.).

The IEMP will examine the potential for risks from pesticides in the Santa Clara Valley. Efforts may include some additional monitoring of imported surface water supplies for pesticides, and will include an analysis of the potential for ground water contamination as a result of local use of pesticides. Pesticide use rates are being estimated by the Santa Clara County Department of Agriculture, based on agricultural practices in the county.

Illegal Waste Disposal

Illegal disposal of wastes in surface water, on the land, or in sewers or storm drains can lead to ground water and drinking water contamination. The State DOHS Toxic Substances Control Division has initiated about 390 cases related to improper handling or disposal of toxic substances in Santa Clara County in the past several years. Many of these cases involve disposal in sewers or storm drains. It is also possible that some of the contamination of soils and ground water that has been found at tank sites may be due in part to illegal waste disposal activity, rather than to waste storage. In addition, large volumes of hazardous household products disposed of through septic tanks may find their way into ground water.

Giardia

Giardia Lamblia is a fecal organism that can be transmitted in food and water, and by human contact. It is a human intestinal parasite, and causes giardiasis. Giardia exists in the animal population of the Hetch-Hetch watershed. DOHS has tentatively developed a method for detecting Giardia cysts in water. Using this method, DOHS has monitored the water supply in the Hetch-Hetch watershed, and found occasional cysts in the supply at Groveland (the first user of Hetch Hetchy water) and several other communities.

The long residence time after chlorination in the Hetch Hetchy system provides greater protection from cysts in the the Santa Clara Valley and San Francisco than exists in the watershed. There have been cases of giardiasis in the San Francisco Water Department service area, but the cause of these is not yet known.

The State DOHS has recommended to San Francisco that it begin to filter Hetch-Hetchy water to remove a variety of impurities, including Giardia cysts. The U.S. EPA is considering a similar recommendation.

CORRECTIVE EFFORTS AND FUTURE ACTION

Public agencies with responsibilities in the Santa Clara Valley are addressing ground water and drinking water contamination problems. Some of these efforts have been discussed in the paper; a brief overview is provided below. Individual companies and industry groups also have studies and clean-up efforts underway.

United States Environmental Protection Agency

EPA Region 9 Superfund Program

EPA's involvement with uncontrolled hazardous waste sites is prescribed under CERCLA: the Comprehensive Environmental Response, Compensation, and Liability Act of 1980. Under CERCLA, EPA conducts the program commonly known as Superfund.

Under Superfund, EPA locates potentially hazardous sites, assesses the relative hazard they present, takes immediate action (such as drum removal) if a site poses an imminent and substantial hazard, and assures that sites are properly cleaned up and monitored in the long term. After EPA evaluation, the most serious hazardous sites are included on the National Priorities List (NPL). The NPL, updated annually, contains 786 sites, 41 in California.

EPA applies the Hazard Ranking System (HRS) to determine if a site is placed on the NPL. This system considers the hazardous chemicals present, the pathways for their transport, and the population potentially exposed. EPA assigns a score to the hazard at each site. After listing, EPA can spend federal funds to gather data in order to develop alternatives for remedial action. "Remedial action" refers to site-specific clean-up actions to prevent or mitigate the release or migration hazardous substances in the environment.

EPA policy requires that individual sites, rather than of areas, be evaluated using the HRS. This approach is consistent with CERCLA and the National Contingency Plan (NCP) in focusing on specific releases and facilities. Scoring sites individually allows equitable comparison of the relative hazards among all sites nationwide.

When responsible parties are unwilling to cooperate, EPA may use its enforcement authorities to obtain a cleanup. EPA has the authority to order responsible parties to abate the release of hazardous substances into the environment. If the responsible parties refuse to act, EPA can fund a cleanup and then recover treble damages from the responsible parties.

Superfund involvement in Santa Clara Valley began in August 1983, with the evaluation of the IBM and Fairchild sites in south San Jose. In July 1984, EPA evaluated additional sites in the valley, which had been identified with the RWQCB's assistance. Region 9 has proposed 19 sites in Santa Clara County as candidates for the next NPL update, scheduled for October 1984. These sites are indicated on Table 6 and Figure 8.

In Santa Clara County, Superfund will primarily support the RWQCB's monitoring, investigation, and cleanup activities. EPA will consider funding the RWQCB's activities under a cooperative agreement. Superfund contractors will also assist in developing an area-wide solution. Superfund activities are coordinated with local, state, and other federal agencies.

South Bay Ground Water Contamination Task Force

EPA, state, and local agencies formed the South Bay Ground Water Contamination Task Force in July 1984 to assure a comprehensive and coordinated approach to the ground water contamination problem. The Task Force includes managers from those agencies and groups with the responsibility, authority, and resources to address the problem: U.S. Environmental Protection Agency; the Regional Water Quality Control Board; the California Department of Health Services; the Santa Clara Valley Water District; Santa Clara County; and the City Managers Association. EPA and the County are co-chairs.

The Task Force has two principal objectives: 1) to assure that government agencies fully use their authority and resources in addressing the contamination problem; and, 2) to coordinate government efforts. The Task Force will determine the activities necessary to address the problem, and gaps in government authority and duplications of effort will be eliminated to the extent possible. The Task Force will identify tasks, obtain commitments from each agency, and monitor the work performed.

In addition, the Task Force will recommend action to the responsible agencies on the discovery, investigation, and cleanup of sites; establishment of a community involvement program; and prevention of future contamination.

The Task Force meets on the second Thursday of each month at the County Office Building in San Jose. Meetings are open to public and minutes of the meetings will be provided upon request. The Task Force also provides status reports to the advisory committees of the IEMP.

EPA's Integrated Environmental Management Project

EPA is conducting an 18 month study of risks from toxic pollutants in the air, surface water, ground water, and land of the Santa Clara Valley. The purpose of the Integrated Environmental Management Project (IEMP) is to identify and define risks to public health posed by exposure to these contaminants; to assess the relative severity of these risks; and to develop approaches to manage these risks more effectively.

EPA is conducting the IEMP in two stages. The first stage is designed to assess the relative risks to human health from various toxic pollutants, pollution sources, and exposure pathways (e.g., air and drinking water) in order to determine which present more serious risks. This work began in the spring of 1984 and is scheduled for completion in January 1985. During 1985 the IEMP will analyze controls for some of the more serious problems, comparing the effectiveness of those controls in reducing risk.

IEMP's focus is thus broader than Superfund's. Superfund focuses on ground water contamination from industrial sources. The IEMP will analyze the risks associated from a wider range of pollutant sources and pollutants, such as nitrates and THMs. The IEMP will also investigate toxic problems in land and air. The IEMP intends to take an integrated look at toxic pollution in all media, and will analyze the movement of toxics from one medium to another (e.g., the movement of volatile organics from ground water to air during the treatment of contaminated ground water).

EPA created its Integrated Environmental Management Program in 1982. The Santa Clara Valley IEMP is one of three geographic IEMPs in the country (the other two are in Philadelphia and Baltimore). The projects' ultimate objective is to provide ways for local, state, and federal governments to effectively manage risks from toxic pollution.

EPA's decision to conduct its third IEMP in Santa Clara followed extensive discussions with state and local officials, industry representatives, and public interest groups in the area. The IEMP has built upon an active coalition of local institutions responsible for the development of the Hazardous Materials Management Ordinances. The IEMP is coordinated with local governments and regulatory agencies through an Intergovernmental Coordinating Committee. Advice from a range of interested groups is also received through a Public Advisory Committee.

Regional Water Quality Control Board

The RWQCB, based in Oakland, has responsibility at the state level to maintain surface water and ground water quality. The RWQCB's investigative and regulatory activities have played a major role in defining and managing the problem of solvent contamination at underground tank sites throughout the valley.

These activities have been carried out with the state Department of Health Services (DOHS), the primary state agency responsible for the state and federal Superfund programs in California. Both DOHS and the RWQCB have the authority to compel action by industry if necessary, and some clean up and abatement orders have been issued by the Board. Due to the extent of voluntary compliance, however, large numbers of enforcement actions have been unnecessary.

As described earlier, the Board's tank leak detection program began in 1982. The RWQCB identified potential tank sites throughout the valley, mailed detailed questionnaires to the owners, and required selected sites with solvent tanks to monitor for soil and ground water contamination.

Using EPA funds provided under Section 205(j) of the Clean Water Act, the RWQCB is working to determine the significance of the results. The Santa Clara Valley Water District is supporting the Board in this effort. The report from the first phase of the 205(j) study will be completed in late 1984.

This White Paper provides an early summary of some of the results of this study, and uses data and exhibits prepared for the report. The RWQCB has submitted a proposal for continued EPA funding of these efforts.

Santa Clara Valley Water District

The SCVWD, while not a regulatory agency, is concerned with water quality in assuring an adequate supply of safe water. Its main offices are in San Jose. The district has developed considerable expertise on the valley's ground water system. As the agency that collects pump charges, the SCVWD has the most complete data base on wells. The District is using these capabilities to assist the RWQCB in its 205(j) study by assembling data and exhibits and reviewing assessments of contamination.

The District has encouraged water retailers to test their wells more frequently than required by previous legislation. The SCVWD regulates well construction and abandonment, and is investigating and sealing abandoned wells which pose the greatest risk of acting as conduits for the transport of contamination from the upper aquifers to the lower aquifer.

The SCVWD is also reducing THM levels in treated South Bay Aqueduct water by switching from chlorination to a combination of chlorine and ammonia at its treatment plants. The SCVWD's ground water recharge activities in South County, along with those of the companion Gavilan Water District which operates in the area south of Gilroy, should gradually reduce nitrate levels.

California Department of Health Services

DOHS has three primary components—all based in Berkeley—involved with the Santa Clara Valley's ground water and drinking water. The Toxic Substances Control Division is responsible for administering the state and federal Superfund programs to clean up sites contaminated by hazardous materials. As a result, the Department has been active in study and remedial actions at major spill and leak sites in the valley.

The Department's Sanitary Engineering Branch is responsible for reviewing, monitoring, and approving sources of drinking water supply for communities across the state. DOHS exercises this responsibility directly for systems with 200 or more connections. It has delegated authority for smaller systems to the Santa Clara County Department of Public Health, although DOHS is available to provide assistance. Under this program, any water utility of five or more connections must receive a water permit which approves its source.

When a water source presents a potential hazard to its users, DOHS is responsible for assessing the hazard and evaluating the availability of other sources of drinking water. If a source is unusable, DOHS notifies the purveyor of the need to discontinue its use and to provide water from other sources.

The Department's Epidemiological Studies Section conducts health analyses and risk assessments across the state, including efforts in the Santa Clara Valley. DOHS has written unpublished internal guidelines which include action levels on most of the commonly found industrial pollutants. Other exotic chemicals are evaluated on a case-by-case basis, referring to current toxicological literature.

Santa Clara County Department of Public Health

The county health department fulfills a broad mandate to protect and promote public well-being. The County Health Officer regulates all water systems with 5 to 199 connections; inspects permitted destruction of wells; and enforces the Hazardous Materials Ordinance in unincorporated areas of the county and in the cities of Saratoga, Monte Sereno, Los Altos, and Los Altos Hills.

This department played an important role in anticipating and assessing water quality problems from hazardous materials storage and handling in the Santa Clara Valley. Under department authority, well monitoring was required that might otherwise not have taken place. Working with the SCVWD, the department collected comprehensive data on nitrate contamination in South County. The department oversees a program of sampling private wells in the county, and works with state agencies on ground water contamination and leak detection programs. Constraints have delayed testing some private wells threatened by contamination in the Mountain View area.

Local Government

The authority of local government in assessing and cleaning up ground water contamination is limited, although cities have the primary responsibility for cleaning up above-ground spills of hazardous substances. Local government in Santa Clara County has helped to reduce the chance of future ground water contamination problems with the passage of the Hazardous Materials Management Ordinances (EMOs). The ordinances are the most important contributions of local government in addressing ground water contamination. They were passed by the county and most of the cities on their own initiative.

The local ordinances are more stringent than the state's, and include the regulation of tanks above ground. Local government is responsible for implementing, monitoring, and enforcing the EMOs, and for removing and repairing leaking tanks before contamination reaches ground water.

Some cities in the valley are major water purveyors, and have the corresponding responsibilities described earlier. These responsibilities include monitoring, and treatment when necessary.

There is no regular monitoring of private wells in the valley. The cities may take the responsibility for monitoring these wells in the future, or for arranging for users to hook up to available municipal systems.

The cities are represented on the South Bay Ground Water Contamination Task Force and the IEMP's advisory committees. The Task Force and the IEMP Through the Task Force and its involvement with the IEMP, local government has continued to serve as a link between the cities and county, and state and federal agencies. Local government will continue to inform the public about the water pollution problems in the valley.

Water Purveyors

The valley's water purveyors include the private water companies and municipal agencies that provide water to most of the valley. They provide information to the appropriate agencies whenever contamination problems are discovered. In cases of contamination from toxics, purveyors provide information on areas affected or potentially affected, including hydrogeological data, flow rates and velocities, and historical and current monitoring data. The purveyors are uninvolved in the cleanup process beyond providing the necessary information, or treating water when required by DOHS. In some cases water contaminated by nitrates is diluted by blending with water from other sources. Whenever possible, the purveyors will work to provide alternate sources when water has been contaminated beyond state action levels. The purveyors also conduct regular monitoring of sources, as discussed on page 5.

Industry

In response to the ground water contamination at Fairchild Camera and Instrument detected in 1981, manufacturing firms in Santa Clara County convened a consortium of trade associations called the Industry Environmental Coordinating Committee (IECC). The IECC worked with county and municipal governments and with environmental groups in drafting the local Hazardous Materials Management Ordinance to protect against future contamination. During 1981 and 1982, some firms also conducted tests on their own initiative which resulted in the detection of 21 additional contamination incidents.

Many firms in the area have implemented specific controls to prevent the spread of ground water contamination from their facilities. In Mountain View, companies have funded homeowners whose private wells had been contaminated so that those households could tie in to the public water supply systems. There and elsewhere in the County, firms have conducted monitoring for toxic contamination, either independently or in response to the RWQCB's leak detection program. Some have installed extraction wells to control the spread of contamination and to remove contaminated water from the aquifer. These efforts are discussed on page 8.

APPENDIX A

FACTORS INFLUENCING THE TRANSPORT AND FATE OF CONTAMINANTS IN GROUNDWATER

The degree of public exposure to contaminants released into the subsurface will depend on several factors that control the transport and fate of such contaminants. This appendix outlines the factors that are generally thought to be the most important. With this base, discussions elsewhere in the white paper (e.g. Appendix B) can be better understood. In addition, this appendix illustrates the uncertainty that surrounds these issues. A range of questions that must be answered in order to understand existing and potential distributions of contaminants underground, and only rough answers are possible for some of these questions.

Hydrogeology

Hydrogeologic factors which control the movement of water below the ground surface are of primary importance. Detailed and accurate information on the direction and rate of movement of ground water at any place and time of interest is rarely available.

Figure A-1 illustrates a generalized schematic vertical section of the subsurface, showing that there may be a complex distribution of geologic media which results in complex ground water distribution and flow patterns. In this idealized example, the subsurface is composed of sand zones and clay zones, the former much more permeable to water flow than the latter. Permeable zones containing water are called aquifers while the less permeable strata are called aquitards. Water percolating downward from the ground surface through the unsaturated zone can sit atop or flow along shallow and discontinuous clay aquitards, forming perched water tables. Water may sit atop deeper aquitards in so-called "unconfined" aquifers, generally moving horizontally in response to variations in the level of the water table. Water beneath the deeper aquitards generally moves horizontally within "confined" aquifers in response to similar factors. Flow through the deeper aquitards is usually very small unless, as illustrated in Fig. A-1, there are thin zones, natural discontinuities or wells allowing flow between the aquifers. The flow direction between the aquifers may be up or down depending on the relative water pressures in the two aquifers. Appendix B presents a detailed description of the hydrogeology of the Santa Clara Valley providing real examples of the idealized features just illustrated.

Contaminant Transport and Fate

Although contaminants released to the subsurface may largely move in response to the flow of groundwater, there are other factors and processes that may result in contaminant movement differing substantially from that of the groundwater. Figure A-2 illustrates the more important of these, which are briefly discussed below.

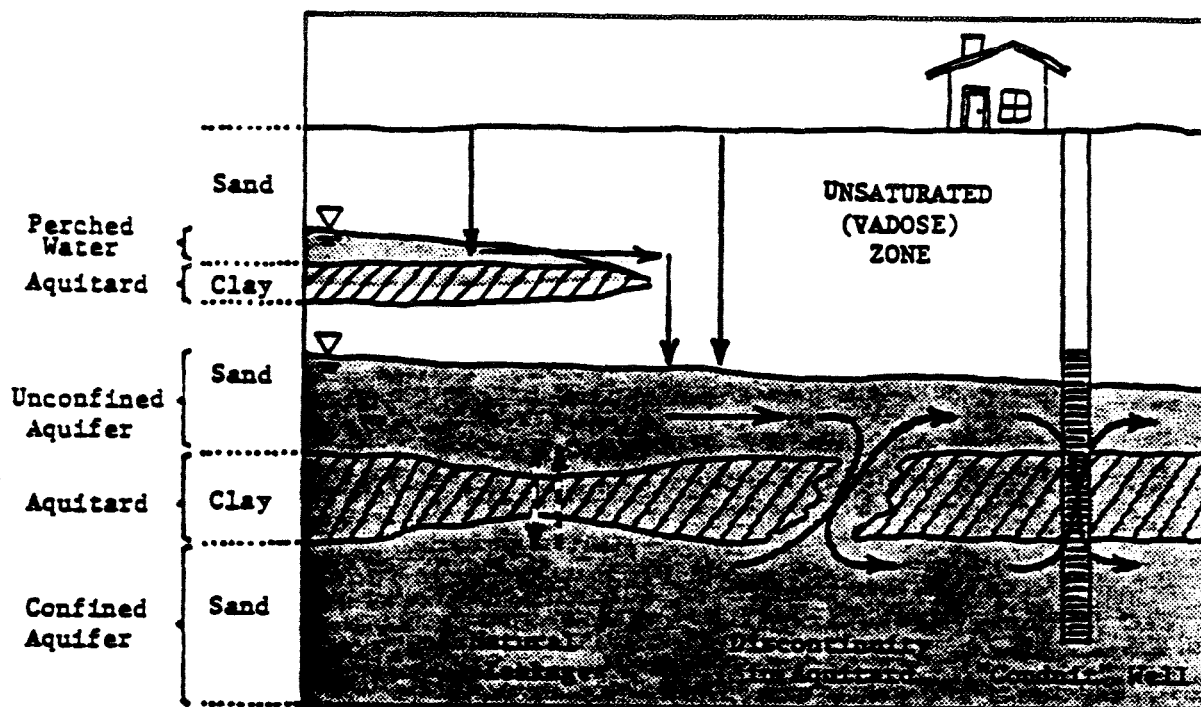


Figure A-1

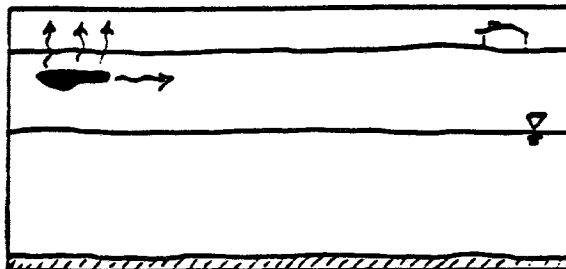
Schematic illustration of natural or man-made hydrogeologic factors. Shading indicates zones fully saturated with ground water. Arrows illustrate the possible direction of ground water flow. The symbol denotes the water table.

Figure A-2 Factors affecting contaminant transport and fate.

A-3

VOLATILIZATION

Movement of contaminant into the gas phase, either in the unsaturated zone or into the atmosphere

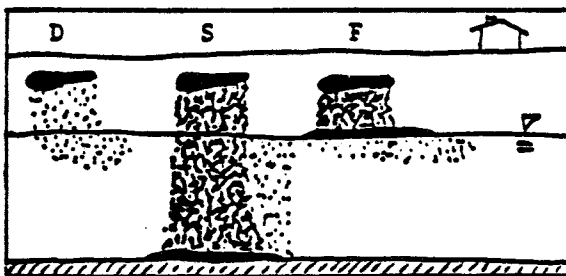


GRAVITY FLOW

D = Dissolved in water

S = "Sinker," a liquid contaminant more dense than water

F = "Floater," a liquid contaminant less dense than water

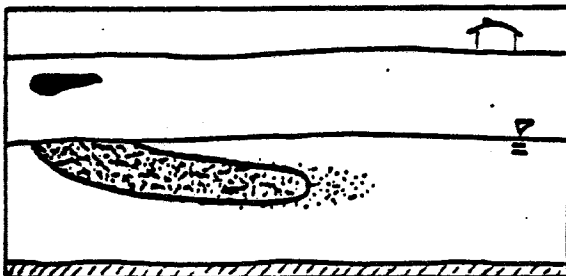


DISPERSION IN GROUNDWATER FLOW

Extent of contamination:

> No dispersion

⊞ With dispersion

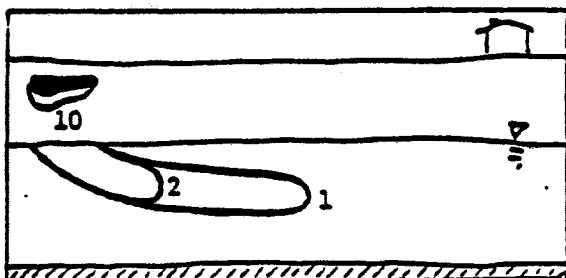


INTERACTION WITH SOIL OR SEDIMENT

1 = None, a conservative solute

2 = Slight, a retarded solute

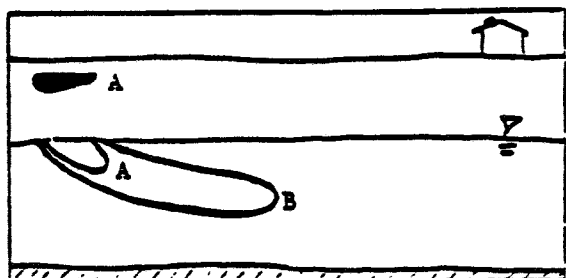
10 = Strong, a retarded solute



TRANSFORMATION

Chemical A → Chemical B

Note: Chemical A might be degraded to harmless products such as water and carbon dioxide



Volatilization

Some chemicals, including many organic solvents and gasoline constituents, are relatively volatile. When such a contaminant is released to the subsurface, a portion may become a vapor which can move out of the soil into the atmosphere or, possibly, move within air-filled pores in soil comprising the unsaturated zone. The extent of such volatilization would depend on the characteristics of the chemical, the temperature, the manner of chemical release, and many other factors.

Gravity Flow

After release, liquid contaminants move downward under the influence of gravity. If the liquid is actually just water containing dissolved contaminants, the liquid will move downward to the water table and mix with the groundwater, which in the figure is flowing to the right. If the liquid is not water, but rather a pure organic solvent which is more dense than water (e.g. trichloroethylene), it is thought that under some conditions the liquid contaminant can "sink" downward through the groundwater zone, leaving a trail of liquid droplets behind that can slowly dissolve into passing groundwater. If enough of the liquid "sinker" is present it may even form a pool on the surface of the aquitard. On the other hand, if a liquid organic contaminant is less dense than water (e.g. gasoline), it may "float" on the water table, slowly dissolving into the water passing beneath it. Although there is field evidence from other parts of the country for the floating and sinking phenomena, it is not currently possible to predict with confidence the rate of descent and/or dissolution of liquid organic contaminants.

Dispersion

Contaminants dissolved in groundwater are transported by the groundwater flow. Because of the complex nature of flow through porous media composed of various grain sizes and shapes, contaminants disperse, or spread out, as they are transported by ground water. This spreading is usually much more pronounced in the horizontal directions than in the vertical direction. The figure (Fig. A-2) shows that dispersion spreads the contaminant front; for contaminants that move freely with the groundwater, this can lead to the contaminant front appearing to move more rapidly than the average velocity of the groundwater (the "no dispersion" front in the figure).

Interaction with Soil or Sediment

Most contaminants of concern do not move freely with the groundwater due to their interaction with the aquifer sediments (e.g. sorption, ion-exchange, etc.). In figure A-2, the effect of such interactions is illustrated by plotting contaminant fronts at one point in time for three chemicals, assuming for clarity that there is no dispersion. The chemical denoted "1" is moves freely with the water, i.e. does not interact with the sediment (a "conservative" chemical). Chemical 2 interacts to a slight and uniform degree as it travels such that its movement is about one-half of that of chemical 1; chemical 2 would be described as being retarded by a factor of two. Chemical 10 interacts

to a greater degree and is retarded by a factor of ten. The degree to which a specific chemical of interest interacts with the aquifer solids depends on the characteristics of both the chemical and the aquifer solids, and may depend on other factors as well (e.g. groundwater composition). Evidence for retardation of dissolved organic contaminants has arisen from various field studies, including one conducted several years ago in the Palo Alto Baylands.

Chemical interactions with aquifer sediments may also alter those sediments, allowing faster transport through confining layers than would otherwise be the case. Laboratory experiments with solvents such as carbon tetrachloride, trichloroethylene and xylene have shown that these solvents in pure form can degrade clay-rich materials. The clay minerals used in these studies may be more susceptible to chemical attack than the silty materials that form the confining layer in the Santa Clara Valley.

The scientific community remains divided on the practical importance of this effect and whether it occurs at all under natural conditions. Thus, it is not currently possible to predict whether such effects are occurring or will occur in the confining layer in the valley.

Transformation

Some contaminants may be transformed by biological or chemical reaction, yielding either harmless inorganic products such as carbon dioxide and water or some intermediate product. In the former case, the contaminant is completely degraded. In the latter case, the new product may itself be of concern. In Fig. A-2, Chemical A is assumed to transform in the groundwater to chemical B due to naturally present microbiological flora. Thus chemical A is not found far from the source, while chemical B may be transported with the groundwater (unless it too can eventually be transformed). Not much is currently known about transformations of organic chemicals in groundwater. It is believed that transformations induced by natural microorganisms can and do occur and that microbiological transformations are probably generally more rapid than chemical transformations, though still relatively slow (half lives from weeks to months). However, there is currently virtually no ability to predict whether and at what rate transformation of a specific chemical would take place.

APPENDIX B

HYDROGEOLOGY AND GROUND WATER CONDITIONS IN THE SANTA CLARA VALLEY

The Santa Clara Valley is a large structural depression, filled with alluvial (stream) and lacustrine (lake) deposits. There are three ground water subbasins in Santa Clara County: the Santa Clara, Coyote, and Llagas. The northernmost, the Santa Clara, is bounded on the north by the alluvial plains of San Mateo County, south San Francisco Bay, and the Niles Cone area of Alameda County. It becomes narrower to the south-southeast and eventually ends at the Coyote Narrows. The Coyote subbasin, part of north Santa Clara Valley, extends from the Coyote Narrows to near Morgan Hill. The Llagas subbasin is south of Morgan Hill and is part of south Santa Clara Valley. This subbasin extends south past Gilroy. Figure B-1 (which duplicates Figure 1 from the text) shows the locations of these three subbasins.

Ford, et. al. (1975) described groundwater conditions in the Santa Clara subbasin; additional information was provided by Iwamura (1980). Ford (1981) described groundwater conditions in the Coyote and Llagas subbasins, and additional information on the Coyote subbasin was provided by Brown and Caldwell-Geotechnical Consultants, Inc. (1981).

Subsurface Geology

Gently sloping alluvial basins extend from the elevated edges of the subbasins to the interior. Unconsolidated to semi-consolidated alluvial deposits comprise the major aquifers of the Santa Clara Valley. Tidal and marine deposits of the baylands are near the southern portions of the San Francisco Bay. Streams draining into the bay are entrenched into the fine-grained bayland deposits. Consolidated rocks of the surrounding mountains are relatively impermeable and do not normally supply significant amounts of water, except to small-capacity domestic wells. The maximum depth to bedrock in the Santa Clara subbasin is over 1,500 feet, although few aquifers are below 800 feet.

As in many alluvial basins, coarser and more permeable deposits exist along the elevated edges of the subbasins, whereas finer and less permeable deposits are in the interior of the subbasins. When the coarser materials lie below the water table they generally comprise water-producing strata, whereas the finer materials comprise intervening confining beds. Confining beds are thus limited near the elevated edges of the subbasins. Conversely, in the subbasin interiors, confining beds are predominant and water-producing strata are generally thinner.

Ground water in individual strata at various depths generally behaves as a single aquifer in the elevated upper fan areas in the southern portions of the Santa Clara subbasin. Water table or unconfined conditions normally prevail in this area, known as the forebay or recharge zone. This is the primary area for recharge.

Moving north down the alluvial fans toward the bay, clays become more predominant in the subsurface and numerous individual water-producing strata exist. These strata have been grouped into the upper and lower aquifers. In general, water in the lower aquifer is confined under an extensive layer, which acts as a confining bed. Thus this area is sometimes termed the confined zone. Water in the upper aquifer may be confined or unconfined, depending on local conditions. The extensive confining bed that separates these two major aquifers is about 100 to 150 feet beneath the land surface in the baylands area, and about 150 to 250 feet in the mid to lower fan area. This confining bed thins toward the forebay and eventually disappears near its edge. Figure B-2 is a simplified schematic of the major hydrogeological structures in the Santa Clara subbasin.

In general, groundwater in the upper aquifer is unconfined in the mid-fan areas but is confined near the toe of the fans and in the baylands, where numerous shallow confining beds are often predominant. These beds are locally termed the "clay cap". In addition, shallow perched groundwater is present locally, particularly in areas where the upper aquifer is confined. The perched water is usually found at depths of less than 20 feet below the land surface.

In the baylands area, the aquifer system generally comprises stream channels filled with sand and gravel surrounded by clay. Buried in alluvial basins, these stream channels are long and narrow. Such water-producing strata are referred to as "shoe-string aquifers" because of their geometry. The buried stream channels extend from the upper and mid-fan areas to beneath the bay, following the trend of present-day stream channels. Ford, et. al. (1975) and Ford (1981) analyzed the extent of these buried stream channels at various depths in the Santa Clara Valley.

The buried stream channels are not distributed uniformly throughout the Santa Clara subbasin. In the upper aquifer, numerous buried stream channels exist near Guadalupe Creek and Coyote Creek. In the Palo Alto-Mountain View bayfront area, two thin water-producing strata have been delineated in the upper aquifer (the "20-foot" and "45-foot" sands). No significant water-producing strata have been found in the upper aquifer in the Santa Clara and Sunnyvale bayfront area.

Most pumpage from large-capacity wells in the Santa Clara subbasin is from the lower aquifer. However, some individual domestic wells less than 150 feet deep tap the upper aquifer. Some large-capacity wells tap both the upper and lower aquifers.

The alluvial deposits in the Coyote and Llagas subbasins overlie a bedrock trough, which deepens to the south. Alluvial deposits are about 165 feet thick near Coyote and thicker to the south. These deposits are about 260 feet thick several miles south of Coyote, and are more than 900 feet thick near Gilroy. Ford (1981) identified numerous buried stream channels in these two subbasins. Two channel systems exist north of Morgan Hill. The lower is near sea level and related to an ancestral southward-flowing Coyote Creek. Northward-trending Coyote Creek deposits are increasingly found just above sea level. A number of buried Coyote Creek stream channels are south of Morgan Hill.

Lacustrine deposits exist in the southern part of the Llagas subbasin. These fairly continuous clays form a series of confining beds. The lacustrine deposits extend as far north as San Martin, where they are about 165 feet deep. The lake deposits become progressively thicker as they slope to the south. Ground water above this clay is generally unconfined, whereas deeper ground water south of San Martin is confined.

Water Levels

The Santa Clara Valley Water District (SCVWD) annually measures depth to water in about 350 wells in the three subbasins. SCVWD prepares maps showing depth to water contours (distances to ground water from the land surface) and ground water elevation contours (ground water levels relative to sea level). Depths to water provide a measure of how deep wells must be to reach water, but tell little about how water will move underground. In the Llagas subbasin depths to water ranged from less than 20 to 100 feet in October, 1981. Depth to water in this subbasin generally increases to the east. Depth to water in the Coyote subbasin in October 1981 usually ranged from less than 20 to about 30 feet. In the Santa Clara subbasin, depth to water ranged from less than 20 feet near the bay, near Saratoga, and near Coyote, to almost 200 feet in some pumping depressions.

Ground water elevations tell more about how ground water behaves. Figure B-3 is a ground water elevation contour map reflecting conditions in September, 1982. (Because seasonal lows in water levels normally occur in September, water-level maps are usually prepared for the fall of the year.) This map reflects conditions in the major water-producing strata tapped by those wells that are measured. Thus, in some areas these water levels are for unconfined aquifers, and in some areas for the deep confined aquifer. Maps to show conditions only in the upper or confined aquifer have not been prepared.

Water-level elevations exceeded 300 feet in October, 1982 at the ground water divide near Morgan Hill. Ground water flows to the southeast in the Llagas subbasin, past Gilroy and toward Hollister. Water-level elevations beneath Gilroy were about 150 feet in October 1982. Ground water flows to the northwest in the Coyote subbasin. In October 1982, water-level elevations were about 230 feet near Coyote.

In the Santa Clara subbasin, the direction of groundwater flow is from the elevated edges of the subbasin to the interior, and largely toward wells which produce pumping depressions. Water-level elevations in October 1982 ranged from greater than 300 feet near Saratoga and east of San Jose to below sea level in some pumping depressions, such as near Mountain View, Sunnyvale, and San Jose.

The vertical flow in the Santa Clara subbasin is predominantly downward, due largely to the effects of pumping. Water levels in deeper wells are generally much lower than those in shallow wells. This occurs because much of the pumpage in the Santa Clara subbasin is from the lower aquifer, whereas recharge originates from the land surface.

Recharge in the forebay and the unconfined part of the upper aquifer in the Santa Clara subbasin occurs through four mechanisms: deep percolation

of rainfall, streamflow, excess applied irrigation water, and artificial recharge. Recharge to confined parts of the upper aquifer and to the lower aquifer is primarily from groundwater inflow from the forebay, and partially from downward leakage of water from overlying strata.

Figure B-4 shows a typical water-level hydrograph for the Santa Clara subbasin. Under natural conditions water levels were shallow, and groundwater in the upper aquifer discharged into the Bay. Water levels in the lower aquifer were above the land surface in the interior part of the subbasin, and in the area beneath the south part of the bay. Water levels generally declined from 1916 to 1935, a period of below normal rainfall in which ground water pumpage increased. Water levels dropped and natural discharges to the bay from the upper aquifer essentially stopped. Water levels in the wells tapping the lower aquifer fell below the land surface. Levels then rose until 1943 due to a series of wet years, and then declined until 1950 due to another series of dry years and increased pumpage.

Water levels were the lowest in the mid-1960s as pumpage increased. Almost 13 feet of subsidence occurred near downtown San Jose. In the baylands area, subsidence totaled about 5 feet. In the mid-1960s, the subbasin was at its greatest rate of overdraft. Since then, water levels have risen due to reduced pumping and extensive artificial recharge. By 1983, depth to water was approximately the same as in the early 1940s. These subsidence problems provided an important impetus toward intensive management of the Santa Clara Valley aquifers. Due to these management practices, subsidence has now essentially been halted.

Long-term water-level records in the Coyote subbasin indicate little or no overdraft. Controlled releases from Anderson Reservoir on Coyote Creek enhance recharge. The Llagas subbasin is in a state of ground water overdraft, primarily because of the small natural recharge and the area's dependence on ground water. Although depth to water was generally about 20 to 30 feet below ground surface in 1914, by the end of the 1975-77 draught water levels were at a depth of 100 to 130 feet, the lowest recorded during the period. The SCVWD and other agencies operate a number of artificial recharge facilities in the Llagas subbasin.

Aquifer Characteristics

Knowledge of aquifer characteristics in the three subbasins is limited, because few of the field tests needed to determine aquifer characteristics have been completed. Some tests have been performed as part of the SCVWD's saltwater barrier project at Palo Alto, and recently as part of site-specific groundwater pollution investigations that have been conducted at selected industrial locations.

Two key aquifer characteristics are horizontal and vertical permeability. Permeability is a measure of how easily water flows through geologic material. Horizontal permeability has a big effect on the speed of ground water movement. Vertical permeability determines whether aquifers will be isolated from one another. Permeability is determined by dividing estimated transmissivity by the aquifer thickness.

Transmissivity is a measure of the total volume of water transmitted through a portion of the aquifer. Transmissivity is determined from measurements made in field tests; usually measurements of the specific capacity of a well are used. Specific capacity is a measure of how water levels in a well drop when the well is pumped.

Ground water flow rates are estimated by combining information on permeability, soil porosity and the hydraulic gradient (slope of the water level) in the portion of the aquifer under consideration. Ground water elevation measurements at many wells are combined to determine hydraulic gradients, and these gradients are generally fairly well known in the Santa Clara Valley. Specific porosity values can be estimated from the grainsize descriptions for subsurface materials, using relationships reported in the literature. On this basis, rates of horizontal flow in the valley could range from about 50 to 500 feet per year, and are likely to be in the range of 100 to 200 feet per year in most areas.

Vertical permeability is primarily an issue for the confining layers in the Santa Clara subbasin. Even fine-grained materials (such as the fine silty clays that make up this layer) can transmit some water vertically if a sufficient head gradient, or driving force, is applied. To determine the rate of vertical flow, the vertical head gradient and vertical permeability must be known.

In order to determine vertical permeability, a specialized type of aquifer test must be performed (a leaky aquifer test). This test can only be done at a well, and provides information only about vertical permeability at that point. Such tests are known to have been performed at only one site in the Santa Clara Valley, in the Palo Alto barrier project. In that situation, two water-producing strata in the upper aquifer were determined to be "leaky." That is, a measurable vertical permeability was present for the confining beds over-lying the strata. However, a test on the major confining bed between the upper and lower aquifers indicated no measurable downward leakage.

Information derived from both salt-water intrusion studies (Iwamura, 1980) and recent pollution investigations indicates that minor confining beds (the clay cap) in the upper aquifer are leaky, and downward flow is possible. On the other hand, the only known information on the major confining bed (between the upper and lower aquifer) indicates that it is essentially impermeable. This conclusion is based both on salt-water intrusion studies and results of aquifer tests at the Palo Alto barrier project. However, it should be kept in mind that this conclusion may only be applicable to the bayfront area where those studies were conducted, and not to all parts of the subbasin where the major confining bed is present. It is likely that measurable vertical permeabilities are present in areas where the major confining bed is thin. The greatest vertical head gradients are normally present in public water supply well fields.

Existing and abandoned wells are also potential conduits that could allow downward flow. This has been recognized for some time, particularly in areas of saltwater intrusion.

When wells are installed, the linings or "casings" of the wells are perforated or "screened" at one or more depths to allow water to enter the

well. The area surrounding the casing may also be packed with gravel over a greater length of the well; if so, water will flow into the well from the entire gravel packed zone. If a well is perforated in more than one zone or if a gravel pack extends over more than one zone, the well creates a pathway for mixing ground water in two zones. Abandoned wells can also corrode, creating new perforations in different zones. Where these wells interconnect zones, they can provide conduits to carry contaminants through zones that would otherwise serve to protect some water supplies.

Many more wells have been installed in the Santa Clara Valley than are now in use. Until recently, wells were generally constructed to maximize yields at a low cost, and multiple perforations and long gravel packs helped to do this. Where yield requirements were high (for example, for agricultural wells), deep wells perforated and gravel packed in multiple zones were used. Many small private wells are shallow, however, because an adequate yield for domestic purposes can often be achieved with a shallow well. Only relatively new wells in the valley have been constructed to avoid interconnecting subsurface zones. Standards for well closures are also relatively new, and many abandoned wells have simply been capped without proper sealing.

A county-wide well standard ordinance, covering both the drilling of new wells and abandonment of existing wells, was passed in 1975 to address this concern. In addition, the SCVWD has begun a program to locate and properly abandon unused existing wells that may serve as conduits for migration of poor quality water from one strata to another.

Chemical Quality

In the forebay area of the Santa Clara subbasin, total dissolved solids (TDS) content of the groundwater is usually between 350 to 500 mg/l. Most ground water in the upper and mid-fan areas is calcium-magnesium bicarbonate. In general, the salinity and sodium percent increase with downgradient flow. The groundwater generally changes in type to a mixed-cation bicarbonate type and then eventually to a sodium bicarbonate type, with flow toward the interior. Iwamura (1980) could not distinguish a difference in chemical quality between groundwater in the upper and lower aquifers. However, he did observe that perched groundwater could be distinguished by high TDS content, and often high nitrate content. Perched water generally ranges from the mixed-cation bicarbonate type to the mixed-cation chloride type. Anomalously high boron contents have been found in shallow groundwater in some parts of the subbasin, particularly along Coyote Creek and lower Pentencia Creek.

Chloride contents of San Francisco Bay water south of the Dumbarton Bridge generally range from 10,000 to 17,000 mg/l. The concentration of constituents in Bay water is normally about 20 percent less than normal ocean water, due to fresh water inflow into the Bay. Tidal incursion of Bay water occurs on all streams entering the bay, and has been greatest in the Guadalupe River, where a chloride content of 6,300 mg/l has been measured more than two miles upstream of Alviso. A chloride content of 750 mg/l has been measured in the Guadalupe River near the Montague Expressway. Land-surface subsidence in the Santa Clara subbasin has exacerbated this tidal incursion problem.

The chemical quality of ground water in the Coyote and Llagas subbasins is suitable for most uses. However, the water is often hard (greater than 200 mg/l total hardness), and nitrate contents commonly exceed 45 mg/l, particularly in the San Martin area.

Salt-Water Intrusion

Iwamura (1980) summarized information on salt-water intrusion in the Santa Clara Valley. The upper aquifer near the bay is extensively intruded by saltwater. The inland extent of intrusion east of Mountain View is approximately along the Bayshore Freeway. Northwest of Mountain View, the inland extent is generally near the Bayshore Freeway. The greatest inland intrusion occurs along Guadalupe River and Coyote Creek. The causative factor is likely the presence of tidal saltwater periodically occurring inland along the stream channels and the abundance of shallow water-producing strata.

Intrusion of the lower aquifer is substantially less. The only areas where the lower aquifer is significantly intruded are along Guadalupe Creek and in a small area near Palo Alto. Intrusion of the lower aquifer has been attributed primarily to improperly constructed, maintained, or abandoned wells. Iwamura (1980) cited the extensive area of chloride content between about 100 and 1,000 mg/l in the upper aquifer as evidence that the clay cap is allowing downward leakage of water to that aquifer from saltwater in the stream channels. The saltwater intrusion in the Santa Clara subbasin seems to have been at a somewhat static condition since overdraft ceased.

References

- Brown and Caldwell-Geotechnical Consultants, Inc. "San Martin Area Water Quality Study, Phase One Report." Prepared for the County of Santa Clara. Walnut Creek, California: January 1981.
- Ford, Robert F. "Evaluation of Ground Water Resources; South San Francisco Bay." California Department of Water Resources Bulletin number 118-1, volume four; South Santa Clara County Area. Sacramento: May 1981.
- Ford, Robert F., et al. "Evaluation of Ground Water Resources; South San Francisco Bay." California Department of Water Resources Bulletin number 118-1, volume three; Northern Santa Clara County Area. Sacramento: December 1975.
- Iwamura, Thomas I. "Salt Water Intrusion Investigation in the Santa Clara County Baylands Area, California." San Jose, California: Santa Clara Valley Water District, September 1980.

TABLE 1

GROUND WATER PRODUCTION
IN THE SANTA CLARA SUBBASIN
JUNE 1982 TO JUNE 1983

	Total Water Production (acre feet)*		
	Agricultural Uses	Non-agricultural Uses	All Uses
Major Water Companies	187	120,082	120,269
Small Systems and Private Wells	5,751	20,227	25,978
Totals	5,938	140,309	146,247

*One acre foot = 326,000 gallons

Source: SCVWD records of water production

TABLE 2
CHARACTERISTICS OF MAJOR WATER PURVEYORS¹

Map Code	Purveyor and Zone	1983 Production (acre feet)	Population ² Served	Wells in Use	Minimum ³ Depth (feet)	Source of Water ⁴ (percent)			
						GW	HH	SCWD	SW
1	City of Palo Alto	16,749	56,000	0 ^d	367(wd)	1	99	0	0
2	City of Mountain View	15,950	60,000	3 ^b	232	13	87	0	0
3	City of Sunnyvale ¹³	28,755	212,000	10	208	25	43	32	0
4	Purissima Hills Water District	1,467	6,500	0	NA	0	100	0	0
5	California Water Services Company ¹⁴	13,641	17,000	38	114 ^f	42	0	58	0
6	City of Cupertino	2,819	25,000	2	298	0.2	0	99.8	0
7	City of Santa Clara	31,340	13,300	27	256	83	8	9	0
8	City of San Jose/Alviso Zone	2,095	233 ⁱ	0 ^j	170	0	100	0	0
9	City of Milpitas	6,548	41,000	0 ^e	288(wd)	0	100	0	0
10	San Jose Water Company	142,995	700,000	149	54	55	0	33	12
11	City of San Jose/Evergreen Zone ^{5,6}	7,074	43,600	3 ^k	100	9	0	91	0
12	Great Oaks Water Company	14,396	60,000	10 ^a	250(wd)	100	0	0	0
13	City of Morgan Hill	24,022	19,000	9	114	100	0	0	0
14	West San Martin Water Works	NA	300	2	80	100	0	0	0
15	City of Gilroy	38,936	26,200	6 ^c	302(wd)	100	0	0	0
16	Redwood Mutual Water Company	115	1,300	1	m	60	0	0	40

TABLE 2 (continued)
CHARACTERISTICS OF MAJOR WATER PURVEYORS

Map Code	Purveyor and Zone	1983 Production (acre feet)	Population ² Served	Wells in Use	Minimum ³ Depth (feet)	Source of Water ⁴ (percent)			
						GW	HE	SCWD	SW
A	Magic Sands Mobile Home Park	not available	700	1	not available	100	0	0	0
B	Rancho Santa Teresa Mobile Home Park	not available	628	2	not available	100	0	0	0
C	Caribee's Mobile Home Park	62	1,000	2	not available	100	0	0	0
	Stanford Univ.	2,708	11,000	0	NA	0	100	0	0
	Moffett Field	1,502		NA	not available	0	100	0	0
	City of San Jose - Edenvale Zone	80 ⁿ	5 ⁱ	3	160	100	0	0	0
-	-	-	-	-	-	-	-	-	-
SJWC Zones ⁷									
	Cambrian			49	145 ⁹	88	0	12	0
	Columbine ⁸			19	210(wd)	51	0	49	0
	Miguelito ⁹			0	NA	0	0	100	0
	More			0	NA	0	0	100	0
	Cox			5	275	56	0	44	0
	Vickery ¹⁰			2	314	70	0	23	7
	Montevina ¹¹			0	NA	0	0	100	0
	Almaden			0	NA	0	0	100	0
	Dow ⁶			57	72 ^h	100	0	0	0
	Belgatos ¹²			6	50	100	0	0	0

TABLE 2 (continued)

- 1 Systems with 200 or more hookups, except West San Martin Water Works.
 - 2 Estimates from water purveyors when available. In other cases, population figures are from the annual reports of the purveyors to DOHS.
 - 3 Depth from land surface to highest perforation or to sanitary seal, unless marked "(wd)," which indicates well depth, for cases when depth to perforation is unknown.
 - 4 GW is ground water, HH is treated water from the Hetch Hetchy Aqueduct, SCWD is treated water from the South Bay Aqueduct (supplied by SCWD), and SW is local surface water.
 - 5 GW percentage shown is average for City of San Jose Alviso and Evergreen Zones.
 - 6 Some treated well water is used in this zone.
 - 7 Breakouts to zones are approximate. Wells are assigned to zone serviced if located in another zone. Wells serving multiple zones are generally counted in both zones, but with production apportioned between zones.
 - 8 Includes Upper Northwood, Pleasant Vista, San Ramon
 - 9 Includes Sunset Hills, Dutard, Alum Rock
 - 10 Includes Saratoga Hills, Elva, Crisp, Lumbertown, and the N.W. portion of Overlook.
 - 11 Includes Greenridge, Mt. Springs, Ravina, Cypress, High Street, Mireval, and the S.E. portion of Overlook.
 - 12 Includes Webb Canyon, Montego. Some treated well water is used in this zone.
 - 13 There are three service zones in this system. Users north of Maude Avenue receive exclusively HH water. Other users receive a mix of HH and well water, or SCWD water blended with a small proportion of well water.
 - 14 A portion of this area near Santa Clara and north of Homestead Road receives exclusively ground water.
- a Also three wells removed from service due to contamination.
- b Also two standby wells.
- c Also one well shut down due to high nitrate levels. Two wells were recently closed temporarily.
- d Also 10 standby wells.
- e Also two standby wells
- f Also includes one well 636 feet deep, one well 470 feet deep, and one well 300 feet deep with unknown perforation depths
- g Also includes one well 210 feet deep with an unknown perforation depth.

TABLE 2 (continued)

- h Also includes one well 315 feet deep and one well 800 feet deep with unknown perforation depths.
- i 5 hookups at commercial park; non-residential.
- j Ground water from 4 wells will be used beginning in January 1985.
- k Seasonal supplement to supply.
- m Spring source; near surface.
- n Estimate for 1984.

TABLE 3

DRINKING WATER STANDARDS AND MONITORING REQUIREMENTS IN CALIFORNIA¹

<u>MONITORED ITEM</u>	<u>MAXIMUM CONTAMINANT LEVELS</u>	<u>FREQUENCY</u>	
		<u>Surface Water</u>	<u>Wells</u>
<u>General Physical Characteristics</u>		as needed	3 years
Color	15 units ²		
Odor	3 units ²		
Turbidity	five units ²		
<u>General Mineral Characteristics³</u>		1 year	3 years
Bicarbonate Alkalinity			
Carbonate Alkalinity			
Calcium			
Chloride	100 ppb ⁴		
Iron	300 ppb		
Magnesium			
Manganese	50 ppb		
Hydroxide Alkalinity			
Total Dissolved Solids			
Copper	1,000 ppb		
pH			
Sodium			
Sulfate	500 ppb ⁴		
Specific Conductance	1,600 microohms ⁴		
Total Hardness			
Foaming Agent (MBAS)	500 ppb		
Zinc	5,000 ppb		
<u>Organic Chemicals</u>		1 year	as needed
Endrin	0.2 ppb		
Lindane	4.0 ppb		
Methoxychlor	100 ppb		
Toxaphene	5.0 ppb		

¹ Only mandatory standards are listed. California standards must be at least as stringent as the mandatory standards set by the U.S. EPA. Recommended maximum contaminant levels and other contaminant standards that are not mandatory have also been proposed for some substances.

² Test methods are specified in the regulations.

³ Standards based on consumer acceptance, rather than health considerations.

⁴ Long term maximums allowed if it is not feasible or reasonable to provide more suitable waters.

TABLE 3 (continued)

DRINKING WATER STANDARDS AND MONITORING REQUIREMENTS

<u>MONITORED ITEM</u>	<u>MAXIMUM CONTAMINANT LEVEL</u>	<u>FREQUENCY</u>	
		<u>Surface Water</u>	<u>Wells</u>
<u>Organic Chemicals (continued)</u>			
Chlorophenoxys 2,4-D	100 ppb		
Chlorophenoxys 2,4-5-T Silvex	10 ppb		
Total Trihalomethanes ⁵	100 ppb		
<u>Inorganic Chemicals</u>		1 year	3 years
Arsenic	50 ppb		
Barium	1,000 ppb		
Cadmium	10 ppb		
Chromium	50 ppb		
Mercury	2.0 ppb		
Selenium	10 ppb		
Silver	50 ppb		
Fluoride	varies ⁶		
Lead	50 ppb ⁷		
Nitrate (as NO ₃)	45 ppm ⁷		
<u>Microbial Contamination</u>		varies with size	
Total coliform bacteria	one per 100 ^a milliliters		
<u>Radioactivity⁸</u>		4 year	4 year
Radium - 226 and 228	5 pCi/liter		
Gross Alpha Particle Activity (Alternate Analysis)	15 pCi/liter		
Gross beta	50 pCi/liter		
Strontium 90	8 pCi/liter		
Tritium	20,000 pCi/liter		

⁵ For water systems with > 10,000 population and chlorinated sources.

⁶ Temperature sensitive.

⁷ Higher levels may be allowed temporarily where alternative water supplies are not available, provided other conditions are met.

⁸ Analyses shall be at 3 month intervals in the year (4 analyses required).

^a This standard is somewhat complex, and depends on the testing method used. Allowable sample variation also depends on sampling frequency, which is related to system size.

TABLE 4

DOHS RECOMMENDED ACTION LEVELS FOR SELECTED CHEMICALS

<u>Chemical</u>	<u>Action Level</u> (parts per billion, ppb)
<u>Pesticides</u>	
<u>Chlorinated Hydrocarbon</u>	
Aldrin	Limit of Quantification (0.05)
a-Benzene Hexachloride (a-BHC)	0.7
b-Benzene hexachloride (b-BHC)	0.3
Chlordane	0.055
Dieldrin	Limit of Quantification (0.05)
Heptachlor	0.02
Heptachlor Epoxide	0.1
Pentachlorophenol	30
<u>Organophosphates</u>	
Dimethoate	140
Diazinon	14
Ethion	35
Malathion	160
Methyl Parathion	30
Parathion	30
Trithion	7
<u>Carbamate</u>	
Aldicarb	10
Beygon	90
<u>Phthalamide</u>	
Captan	350
<u>Amides</u>	
Diphenamide	40
<u>Fumigants</u>	
Dibromochloropropane	1
1,2-Dichloropropane	10
Ethylene Dibromide	Limit of Quantification (0.05)
<u>Miscellaneous</u>	
Terrachlor (Pentachloronitrobenzene)	0.90
<u>Herbicides</u>	
CIPC	350
(isopropyl N (3-chlorophenyl) carbamate)	
Bolero (thiobencarb)	10 (Tentative: 1.0)
Ordram (Molinate)	20
Glyphosate	500

TABLE 4 (continued)

DOHS RECOMMENDED ACTION LEVELS FOR SELECTED CHEMICALS

<u>Chemical</u>	<u>Action Level</u> (parts per billion, ppb)
<u>Purgeable Halocarbons</u>	
Carbon Tetrachloride	5
1,2-Dichloroethane	1
1,1-Dichloroethylene	Limit of Quantification (0.1 - 0.4)
Methylene Chloride	40
Tetrachloroethylene	4
1,1,1-Trichloroethane	200
Trichloroethylene	5
Vinyl Chloride	2
<u>Purgeable Aromatics</u>	
Benzene	0.7
1,2-Dichlorobenzene	130 ^a
1,3-Dichlorobenzene	130 ^b
1,4-Dichlorobenzene ¹	130 ^c
Toluene	100
Ortho-xylene	620
Para-xylene	620
Meta-xylene ²	620
<u>Phenols</u>	
2,4-Dimethylphenol	400 ^d
Phenol	1 ^d

^a Taste and odor threshold is 10.

^b Taste and odor threshold is 20.

^c Taste and odor threshold is 0.3.

^d Same as taste and odor threshold.

¹ Action Level for Dichlorobenzene is either for a single isomer or for the sum of the three isomers.

² Action Level for Xylene is either for a single isomer or for the sum of the three isomers.

TABLE 5
STATUS OF MONITORING EFFORTS**

Purveyor	Last Comprehensive Organics Screen	Type of Test	Testing Frequency	Sampling	AB 1803 Data Expected
City of Cupertino	9/27/83	V.O.C.	Annually	2 samples; wells only	1/4/85*
		Bacteriological	Weekly	8 samples; random, syst.	
		TfMs	Quarterly	8 samples	
		Nitrates	Triennially		
City of Gilroy	7/16/84	V.O.C.	Annually		4/85
		Bacteriological	Weekly		
		TfMs	Annually		
		Nitrates	Weekly		
City of Milpitas	2/82	V.O.C.	Triennially		12/12/84
		Bacteriological	Monthly	15 samples	
		TfMs	Quarterly		
		Nitrates	Triennially		
City of Morgan Hill	7/5/83	V.O.C.	Triennially	All wells	4/13/84
		Bacteriological	Weekly	5-10 samples; system	
		TfMs	Quarterly	8 samples; system	
		Nitrates	Monthly	9 wells	
City of Mountain View	2/82	V.O.C.	Monthly	1 well	12/14/84
			Quarterly	2 wells	
			Triennially	All wells	
		Bacteriological	Weekly	18 samples; system	
		TfMs	Quarterly	4 samples	
		Nitrates	Triennially		
City of Palo Alto	Summer 1982 (emergency wells)	V.O.C.	Triennially	Standby wells and S.F.W.D	3/85
		Bacteriological	Weekly	30 samples, customer tap water	
			Weekly	3 samples; water quality control plant	
		TfMs	Quarterly	System	
		Nitrates	Triennially		
City of San Jose: Evergreen and Edenvale Zones	3/25/82	V.O.C.	Annually	Wells only	some: 11/10/84 all: 6/85
		Bacteriological	Weekly	System	
			Monthly	Wells	
		TfMs	Quarterly	System	
		Nitrates	Triennially		
City of San Jose - Alviso Zone	9/26/83	V.O.C.	Annually	Wells only	6/85*
		Bacteriological	Weekly	System	
			Monthly	Wells	
		TfMs	Quarterly	System	
		Nitrates	Annually		

* These are projected dates for data submission based in most cases on maximum timeframes established in A.B. 1803.

** Minimum required monitoring frequency is reported where actual frequency is not known.

NA = Not applicable

TABLE 6
SANTA CLARA VALLEY CONTAMINATION SITES

PAGE 1

Case Name and Community	Definition of Extent of Contamination		Hazardous Soil Removal		Groundwater Plume Containment	Groundwater Cleanup			Water Supply Wells Affected	Map Code
	# of Wells or Springs	Anticipated Completion	Antic. Begin.	Antic. Compl.	Fully effective by	Antic. Begin.	Extraction Wells	Under Flow (gpm)	PS=Public Sys. P=Private	Figure
*Advanced Micro Devices Sunnyvale	74	Fall '84	Begin	Fall '84	Spring '85	Begin	7	low	0	1
*Alviso Dumping Area ¹ AMI ² Santa Clara										85
Amper Corp. ² Sunnyvale	9	Fall '84	Fall '84	N/A	Spring '85	Fall '84	0	0	0	2
*Applied Materials ² 3050 Bowers Avenue Santa Clara	5	Spring '85	Fall '84	Winter '84	Summer '85	Winter '85	0	0	0	4
Applied Technology ² Sunnyvale	4	Fall '84	N/A	N/A	N/A	N/A	0	0	0	3
Avantek, Inc. ² 3175 Bowers Avenue Santa Clara	5	Summer '85	Winter '84	Winter '84	Fall '85	Summer '85	0	0	0	69
Aydin Energy Division ² 3180 Manover Street Palo Alto	3	Fall '84	Begin	Spring '85	Summer '85	Fall '85	0	0	0	75
Becton, Dickinson, & Co. ² Los Gatos	4	Summer '85	Winter '85	Winter '84	Winter '85	Winter '85	0	0	0	5
Control Data Inc. ² 1333 Scott Blvd Santa Clara	9	Fall '84	Winter '84	Winter '84	Winter '84	Spring '85	0	0	0	70
DAP, Inc. ² San Jose	5	N/A	N/A	N/A	N/A	N/A	0	0	0	8
Data General Corp. Sunnyvale	1	Fall '84	N/A	N/A	Summer '85	N/A	0	0	0	9
Data-Bond Palo Alto	2	Winter '84	Begin	Compl.	Summer '85	Fall '85	0	0	0	10
Dynan ² 5200 Patrick Henry Santa Clara	14	Fall '84	N/A	N/A	Winter '84	Winter '84	1	0	0	11

* Underground Tank or Sump.

¹ Site proposed for inclusion on EPA's National Priority List under the Comprehensive Environmental Response and Liability Act ("Superfund").

² Proposed for listing primarily on the basis of asbestos related air risks.

TABLE 6 (continued)

PAGE 2

Case Name and Community	Definition of Extent of Contamination		Hazardous Soil Removal		Groundwater Plume Containment	Groundwater Cleanup			Water Supply Wells Affected	Map Code
	# of Wells or Borings	Anticipated Completion	Antic. Begin.	Antic. Compl.	Fully effective by	Antic. Begin.	Extraction Wells (Number/Flow/gpm)		PS=Public Sys. P= Private	See Figure 7
Dyeen [*] 5301 Patrick Henry Santa Clara										11
Esar Integrated System [*] 750 Palomar Avenue Sunnyvale	1	Fall '84	N/A		Spring '85	N/A	0	0	0	77
Fairchild Camera & Inst. [*] Palo Alto	30	Fall '84	Winter '84	Spring '85	Winter '84	Winter '84	0	0	1(p)	14
"Fairchild Camera & Inst." [*] San Jose	103	Completed	Begin	Compl.	Completed	Begin	22	6,000	1(ps)	16
"Fairchild Camera & Inst." [*] Mountain View			Begin							13
Ford Motor Corp Milpitas										8
Great Western Chem. Co. [*] Milpitas	5	Winter '85	Fall '84	Winter '86	Summer '86	Winter '84	0	0	0	20
Harris Microwave Semi. [*] Milpitas		Begin								21
Hewlett-Packard [*] Mountain View	4	Fall '84	N/A	N/A	Spring '85	Spring '85	0	0	0	26
Hewlett-Packard [*] 974 East Arques Sunnyvale	1	Fall '84	N/A	N/A	Spring '85	Summer '85	0	0	0	78
Hewlett-Packard [*] 11000 Wolfe Road Cupertino	2	Winter '84	Begin	Winter '84	Summer '84	Summer '84	0	0	0	22
"Hewlett-Packard" [*] 1501 Page Mill Palo Alto	10	Spring '85	Begin	Spring '85	Fall '85	Summer '85	0	0	0	25
Hewlett-Packard [*] 640 Page Mill Palo Alto	14	Fall '84	Winter '84	Summer '85	Fall '85	Summer '85	0	0	0	24

* Underground Tank or Sump.

* Site proposed for inclusion on EPA's National Priority List under the Comprehensive Environmental Response and Liability Act ("Superfund").

TABLE 6 (continued)

PAGE 3

Case Name and Community	Definition of Extent of Contamination		Hazardous Soil Removal		Groundwater Plume Containment	Groundwater Cleanup			Water Supply Wells Affected	Map Code See Figure 7
	# of Wells or Sources	Anticipated Completion	Antic. Begin.	Antic. Compl.	Fully effective by	Antic. Begin.	Extraction Wells Number/Flow/gph		PS=Public Sys. P= Private	
Hewlett-Packard [*] Deer Creek Road Palo Alto	7	Completed	Spring '85	Fall '85	Completed	Begin	1	0.5	0	23
Hewlett-Packard [*] 395 Page Mill Palo Alto	1	Fall '84	Begin	Compl.	Winter '84	Winter '84	0	0	0	82
IBM [] 5600 Cottle Road San Jose	306	Fall '84	Begin	Spring '85	Fall '84	Begin	20	5,000	8(ps) 8(p)	27
In-Print Corporation [*] 968 Stewart Drive Sunnyvale	2	Fall '85	N/A	N/A	N/A	N/A	0	0	0	79
Intel Corp. [] Mountain View	42	Summer '85	Fall '84	Winter '84	Winter '84	Begin	1	23	1(p)	28
Intel: Facility III [] Santa Clara	9	Spring '85	N/A	N/A	Winter '84	Winter '84	0	0	0	29
Intel: Magnetics [] Santa Clara	9	Spring '85	N/A	N/A	Winter '84	Winter '84	0	0	0	30
Intersil [*] Sunnyvale	2	Summer '85	Un- known	Unknown	N/A	Spring '85	0	0	0	31
Jones Chemical [*] Milpitas	33	Spring '85	—	—	Spring '85	Fall '84	4	0	0	32
KII [*] Sunnyvale	4	Winter '84	Spring '85	Spring '85	Spring '85	Spring '85	0	0	0	33
Lorants Barrel & Drum [] San Jose	3	Fall '84	Begin	Summer '85	Spring '84	Winter '84	0	0	0	34
Megrex [*] San Jose	1	Fall '84	N/A	N/A	N/A	N/A	0	0	0	35
Memorex [*] 1200 Memorex Drive Santa Clara	11	Spring '85	N/A	N/A	Fall '84	Fall '84	1	0	0	36

* Underground Tank or Pump.

* Site proposed for inclusion on EPA's National Priority List under the Comprehensive Environmental Response and Liability Act ("Superfund").

TABLE 6 (continued)

PAGE 4

Case Name and Community	Definition of Extent of Contamination		Hazardous Soil Removal		Groundwater Plume Containment	Groundwater Cleanup			Water Supply Wells Affected	Map Code
	# of Wells or Borings	Anticipated Completion	Antic. Begin.	Antic. Compl.	Fully effective by	Antic. Begin.	Extraction Wells Number Flow (gpm)		PS=Public Sys. P= Private	See Figure 7
Microel Wafer Fab [†] (Advanced LSI) 639 N. Pastoria Avenue Sunnyvale	2	Fall '85	Fall '85	Winter '85	Winter '85	Fall '85	0	0	0	80
Micro-Metallics San Jose	3	Winter '84	N/A	N/A	Winter '86	Spring '85	0	0	0	37
Moffet Naval Air Station [†] Mountain View	21	Summer '85	Summer '86	Fall '86	Summer '86	Winter '85	0	0	0	38
"Monolithic Memories" [†] Sunnyvale	13	Winter '84	N/A	N/A	Summer '85	Summer '85	0	0	0	40
Monmento Santa Clara	16	Fall '84	Winter '84	N/A	Winter '85	Fall '84	0	0	0	39
NEC Electronics Mountain View	18	Winter '84	Summer '85	Fall '85	Summer '85	Summer '85	0	0	1(p)	42
"National Semiconductor" [†] Sunnyvale	40	Spring '85	N/A	N/A	Spring '85	Spring '85	16	0	0	41
Pacific Nursery Pots [†] 1015 Martin Avenue Santa Clara	1	Winter '85	Winter '85	N/A	Winter '88	Fall '84	0	0	0	71
Pierce & Stevens Chem. [†] Milpitas	4	N/A	—	—	Complete	—	0	0	0	43
Precision Media [†] (Allied Media, 1180 Elko Dr.) Sunnyvale	1	Winter '84	Fall '84	Spring '85	Spring '85	Spring '85	0	0	0	67
"Precision Monolithic" [†] Santa Clara	12	Fall '84	N/A	N/A	Spring '85	Fall '84	1	0	0	44
"Raytheon" [†] Mountain View	15	Summer '85	Summer '85	Winter '85	Summer '85	Summer '85	0	0	1(p)	45
Safety-Kleen [†] 3461 Woodward Avenue Santa Clara	5	Spring '85	Summer '85	Fall '85	Summer '85	Fall '85	0	0	0	72

[†] Underground Tank or Dump.

* Site proposed for inclusion on EPA's National Priority List under the Comprehensive Environmental Response and Liability Act ("Superfund").

TABLE 6 (continued)

PAGE 5

Case Name and Community	Definition of Extent of Contamination:		Hazardous Soil Removal		Groundwater Plume Containment	Groundwater Cleanup			Water Supply Wells Affected	Map Code
	# of Wells or Borings	Anticipated Completion	Antic. Begin.	Antic. Compl.	Fully effective by	Antic. Begin.	Extraction Wells (NUMBER FLOWING)		PS=Public Sys. P=Private	See Figure 7
S. Clara County Transit? Agave Terminal 3990 Zanker San Jose										84
S. Clara County Transit? Chaboya Station 7th and Tulley San Jose	40	Fall '84	N/A	N/A	Complete	Begin	16	0	0	83
Siemens Corp.* Cupertino	20	Spring '85	Begin	Winter '85	Fall '85	Spring '85	0	0	0	47
Signetics: 305 Matilda** Sunnyvale										
740 Kifer Road† Sunnyvale	16	Winter '83	Begin	—	Complete	Begin	2	low	0	49
840 Kifer Road† Sunnyvale										50
811 Arques† Sunnyvale	78	Fall '84	Begin	Winter 84	Winter '84	Begin	5	low	0	48
848 & 897 Stewart** Sunnyvale										88
830 Stewart† Sunnyvale										89
730 Evelyn** Sunnyvale										90
3625 Peterson Way† Santa Clara										86
3600 Tannery† Santa Clara										87
Siltec† Mountain View	3	Summer '85	Summer '85	Fall '85	Summer '85	Summer '85	0	0	1(p)	51

† Underground Tank or Susp.

* Site proposed for inclusion on EPA's National Priority List under the Comprehensive Environmental Response and Liability Act ("Superfund").

** An offsite contamination source is suspected.

TABLE 6 (continued)

PAGE 6

Case Name and Community	Definition of Extent of Contamination		Hazardous Soil Removal		Groundwater Plume Containment	Groundwater Cleanup			Water Supply Wells Affected	Map Code
	# of Wells or Borings	Anticipated Completion	Antic. Begin.	Antic. Compl.	Fully effective by	Antic. Begin.	Extraction Wells Number	Flow (gpm)	PS=Public Sys. P= Private	See Figure 7
Solvent Service† San Jose	12	Fall '84	Winter '84	Spring '85	Winter '84	Spring '85	0	0	0	52
Spectra Physics† Santa Clara	1	Fall '85	Begin	Summer '85	N/A	-	0	0	0	53
Sperry Univac† 1330 Scott Blvd. Santa Clara	7	N/A	N/A	N/A	N/A	N/A	0	0	0	
Stanford Cleaners† Palo Alto	1	Winter '85	Winter '84	Summer '85	Spring '85	Spring '85	0	0	0	54
Synetech 3050 Coronado Blvd† Santa Clara										
3001 Stander Way† Santa Clara	6	Spring '85	N/A	N/A	Winter '87	Spring	0	0	0	55
TBW Microwave, Inc.† 825 Stewart Drive Sunnyvale	10	Fall '84	Begin	?	Spring '85	Begin	2	low	0	
Tandem Computers, Inc.† Cupertino	-	Completed	Begin	Com- pleted	Completed	-	0	0	0	56
Technical Coatings† Santa Clara	17	Spring '85	N/A	N/A	Fall '86	Spring '85	0	0	0	57
Teladyne Semiconductor† Mountain View	18	Winter '84	Winter '84	Summer '85	Summer '85	Winter '85	0	0	25 - 45(p)**	58
Timex† 20630 Valley Green Dr. Cupertino	8	Fall '84	Begin	N/A	Winter '84	N/A	0	0	0	
United Technologies† Coyote Center San Jose										60
United Technologies† Sunnyvale	14	Fall '84	N/A	N/A	Spring '85	N/A	0	0	0	61

† Underground Tank or Pump.

* Site proposed for inclusion on EPA's National Priority List under the Comprehensive Environmental Response and Liability Act ("Superfund").

** Approximately 35 drinking water wells were affected.

TABLE 6 (continued)

PAGE 7

Case Name and Community	Definition of Extent of Contamination		Hazardous Soil Removal		Groundwater Plume Containment	Groundwater Cleanup			Water Supply Wells Affected	Map Code
	# of Wells or Springs	Anticipated Completion	Antic. Begin.	Antic. Compl.	Fully effective by	Antic. Begin.	Extraction Wells		PS=Public Sys. P= Private	See Figure 7
Van Waters and Rogers [†] San Jose	16	Fall '84	Summer '85	Summer '85	Winter '85	Spring '85	0	0	0	62
Verbatim Corp. [*] Sunnyvale	2	Winter 84	N/A	N/A	N/A	N/A	0	0	0	63
Western Forge & Flange Santa Clara	0	Winter '84	Fall '84	Fall '84	N/A	N/A	0	0	0	
Westinghouse Electric Sunnyvale	250	Fall '84	Fall '84	-	Summer '85	Spring '85	0	0	0	64
Xidex [†] Sunnyvale	8	Fall '84	Spring '85	Summer '85	Spring '85	Summer '85	0	0	0	65
Syco Corp. [†] Sunnyvale	1	Spring '85	N/A	N/A	Spring '85	N/A	0	0	0	66

[†] Underground Tank or Sump.^{*} Site proposed for inclusion on EPA's National Priority List under the Comprehensive Environmental Response and Liability Act ("Superfund").

TABLE 7
CONTAMINATION LEVELS AT SOME SITES *

PAGE 1

Case Name and Community	Contaminant	Soil (ppb)	Groundwater (ppb)
Advanced Micro Devices Sunnyvale	TCE, TCB	X	X
Ampex Corp. Sunnyvale	Solvents	X	
Applied Materials 3050 Bowers Avenue Santa Clara		X	
Applied Technology Sunnyvale	TCA, TCE		
Avantek, Inc. 3175 Bowers Avenue Palo Alto		X	X
Aydin Energy Division 3180 Hanover Street Palo Alto		X	
Becton, Dickinson, & Co. Los Gatos	Stoddard solvents	> 1000	> 1000
Bell Industries Sunnyvale	1) Freon 2) TCE, Dibutyl phthalate, p-xylene	not tested	1) 100 to 500 2) < 100
Container Corp. of America Santa Clara	Toluene	100 to 500	none
DAP, Inc. San Jose	Methylene Chloride, Chloroform, Toluene, TCA, Freon, Acetone, Xylenes, PCE	not tested	< 100
Data General Corp. Sunnyvale	TCE, Ethylbenzene, Freon	none	500 to 1000
Dysan 5200 Patrick Henry Santa Clara	MEK, IPA, Cellosolve Cyclohexanone	Not tested	> 1000
Dysan 5301 Patrick Henry Santa Clara	IPA	Not tested	> 1000
Economics Laboratory San Jose	Soil: 1) Butyl Cellosolve 2) Aromatic Hydrocarbons Water: 1) Aromatic Hydrocarbons, Butyl Cellosolve	1) 500 to 1000 2) < 100	1) < 100

* Information is as of October, 1983. Abbreviations are explained at the end of the table.

TABLE 7 (continued)

PAGE 2

Case Name and Community	Contaminant	Soil (ppb)	Ground water (ppb)
Fairchild Camera & Instrument Mountain View	TCE, DCE, TCA	X	X
Fairchild Camera & Inst. Santa Clara	TCE	X	X
Fairchild Camera & Inst. Palo Alto	TCE and other solvents	X	X
Fairchild Camera & Inst. San Jose	TCA	X	X
FMC Corp. San Jose	Solvents		
Ford Motor Corp. Milpitas	Soil: 1) Bis 2-ethylhexyl phthalate 2) PCB, Methyl chloride 3) Benzene, Chlorobenzene, TCA, Ethylbenzene, Toluene Water: 1) Ethylbenzene 2) Trans 1,2-DCE, Toluene, Vinyl Chloride, Pentachlorophenol, Naphthalene 3) Benzene, TCE, Bis 2-ethylhexyl phthalate, Methyl chloride, DCA	1) > 1000 2) 100 to 500 3) < 100	1) 500 to 10 2) 100 to 50 3) < 100
Great Western Chem. Co. Milpitas	Soil: 1) TCE, TCA, 1,1-DCE, PCE 2) 1,1-DCA, Toluene 3) DCE Water: 1) DCA, DCE, TCA, TCE, PCE, Toluene	1) > 1000 2) 100 to 500 3) < 100	> 1000
Harris Microwave Semiconductor Milpitas	1) IPA 2) Dichloromethane 3) Acetone	1) > 1000 2) 500 to 1000 3) < 100	none
Hewlett-Packard Mountain View	Soil: 1) Acetone, PCE 2) TCE Water: 1) PCE 2) TCA	1) 100 to 500 2) < 100	1) > 1000 2) < 100
Hewlett-Packard 974 East Arques Sunnyvale		X	X
Hewlett-Packard 11000 Wolfe Road Cupertino	TCE	< 100	none

TABLE 7 (continued)

PAGE 3

Case Name and Community	Contaminant	Soil (ppb)	Ground water (ppb)
Hewlett-Packard 1501 Page Mill Palo Alto	Soil: TCE, TCA, DC, Toluene, Methylene chloride Water: 1) Benzene, Chlorobenzene, 1,2-DCE, Ethylbenzene, Toluene, Freon, Methylene Chloride, Methylcyclohexane, TCE 2) TCA	< 100	1) > 1000 2) 500 to 1000
Hewlett-Packard 640 Page Mill Palo Alto	Soil: TCE Water: TCA, TCE	> 1000	> 1000
Hewlett-Packard Deer Creek Road Palo Alto	TCE	X	X
Hewlett-Packard 395 Page Mill Palo Alto	Soil: 1) TCE 2) PCE, TCA Water: TCA	1) 100 to 500 2) < 100	< 100
IBM 5600 Cottle Road San Jose	TCA, TCE, Freon, Chromium	X	X
Intel Corp. Mountain View	Soil: 1) Ethylbenzene, Xylene 2) TCE 3) Trans-DCE Water: 1) TCE, Trans-DCE, Ethylbenzene, Freon, Acetone, IPA, Xylene 2) DCE, TCA, Vinyl Chloride, Toluene 3) DCA, PCE, Chloroform, MEK	1) > 1000 2) 100 to 500 3) < 100	1) > 1000 2) 100 to 500 3) < 100
Intel: Facility III Santa Clara	TCE, TCA		X
Intel: Magnetics 2880 Northwestern Pky. Santa Clara	Soil: Hexane Water: 1) TCE, Freon 2) TCA	500 to 1000	1) 100 to 500 2) < 100
Intersil Sunnyvale	Soil: TCA, Xylene Water: 1) Trans-1,2-DCE 2) 1,2-Dichloro-1,2,2-tri- fluoroethane 3) 1,1,2-trichlorofluoro- ethane, TCE 4) Vinyl chloride, 1,1-DCE	< 100	1) > 1000 2) 500 to 1000 3) 100 to 500 4) < 100
Jones Chemical Milpitas	TCA	X	X

TABLE 7 (continued)

PAGE 4

Case Name and Community	Contaminant	Soil (ppb)	Ground water (ppb)
KTI Sunnyvale	Water: 1) Mineral Spirits 2) PCE, TCA, DCA	none	1) > 1000 2) < 100
Lorentz Barrel & Drum San Jose	Solvents	X	X
Magnex San Jose	Soil: 1) Trichlorobenzene, Methyloxirane 2) Dimethylbenzene, TCE, PCE	1) > 100 2) 100 to 500	not tested
Micro-Metallics San Jose	Metals, Cyanide	X	X
Moffett N.A.S Mountain View	Soil: 1) TCE 2) Toluene, DCA, DCE, PCE Water: 1) TCE, Toluene, IPA, 2,3-Diethyloxirane 2) DCE 3) Chloroethane, DCE, Xylene, PCE 4) DCA, Freon, Ethylbenzene	1) 100 to 500 2) < 100	1) > 1000 2) 500 to 1000 3) 100 to 500 4) < 100
Monolithic Memories Sunnyvale	Soil: 1) Toluene Water: 1) Ethylbenzene, Xylene, TCE, Chlorobenzene, Toluene 2) Dichlorobenzene 3) PCE, Benzene, DCE, DCA, Freon	1) 100 to 500 2) 500 to 1000 3) < 100	1) > 100
NEC Electronics Mountain View	Soil: 1) Trichlorobenzene, Dichlorobenzene 2) TCE, Freon 3) PCE, TCA Water: 1) TCE, Freon 2) PCE, Hexane, Acetone, Ethylbenzene, Toluene, Benzene	1) >1000 2) 100 to 500 3) < 100	1) 500 to 1000 2) < 100
Pierce&Stevens Chemical Milpitas	Soil: Toluene Water: Acetone	1) > 1000	> 1000
Precision Media Sunnyvale	Hexanone, MEK	X	X

TABLE 7 (continued)

PAGE 5

Case Name and Community	Contaminant	Soil (ppb)	Ground water (ppb)
Precision Monolithic Santa Clara	Soil: 1) Methylene Chloride, TCE, TCA, Freon Water: 1) TCE, DCE, Xylene 2) TCA, DCA 3) Freon, Methylene Chloride, PCE, Toluene	1) < 100	1) > 1000 2) 500 to 1000 3) < 100
Raytheon Mountain View	1) TCA, TCE 2) 1,2-DCE, DCA, PCE 3) DCE, Chloroform, Ethylbenzene	none	1) > 1000 2) 100 to 500 3) < 100
S. Clara County Transit Chaboya Station San Jose	No. 1 Diesel Oil	X	X
Siemens Corp. Cupertino	1) Phenol, Methanol, 1,1,1-Tri- chloroethane, IPA, Xylene, n-Butyl Acetate 2) Acetone 3) Trichlorofluoroethane, Methylene Chloride	1) > 500 2) 100 to 500 3) < 100	none
Signetics 740 Kifer Road Sunnyvale	TCE	X	X
Signetics 860 Kifer Road Sunnyvale	TCE, DCE	X	X
Signetics 811 Arques Avenue Sunnyvale	TCE, TCA	X	X
Siltec Mountain View	Soil: 1) Toluene 2) TCE Water: 1) TCA, TCE, PCE 2) TCA, TCE, Chlorobenzene, Toluene, Ethylbenzene	1) > 1000 2) 500 to 1000	1) > 1000 2) 500 to 1000
Solvent Service San Jose	Soil: 1) TCA, Ethylbenzene, Methy- lene Chloride, PCE, Toluene, TCE, TCA, Xylene Water: 1) TCA, Ethylbenzene, Methylene Chloride, PCE, Toluene, Xylene, Phenol	1) > 1000	1) > 1000
*Spectra Physics Santa Clara	1) Methanol 2) Acetone	1) > 1000 2) 100 to 500	not tested

TABLE 7 (continued)

Case Name and Community	Contaminant	Soil (ppb)	Ground water (ppb)
Sperry Univac 3330 Scott Blvd. Santa Clara		X	X
Stanford Cleaners Palo Alto	1) Stoddard solvents	1) > 1000	none
Synertek, Inc. 3001 Stender Way Santa Clara	Soil: 1) Xylene 2) TCA Water: 1) Xylene, Acetone 2) DCE	1) 500 to 1000 2) 100 to 500	1) > 1000 2) 100 to 500
TRW Microwave, Inc. 825 Stewart Drive Sunnyvale	Soil: Not tested Water: 1) Acetone, n-Butylacetate, p-Xylene, m-Xylene 2) Freon, Trichlorobenzene		1) > 1000 2) < 100
Tandem Computers, Inc. Cupertino	Soil: 1) TCE, Xylene 2) Freon Water: None	1) > 1000 2) 500 to 1000	
Technical Coatings Santa Clara	1) Diesel Fuel, Naphtha, Xylene, Toluene, Cellosolve, Acetate 2) MEK	none	1) >1000 2) 500 to 1000
Teledyne Semiconductor Mountain View	Soil: 1) TCE, PCE, Freon, Dichlorobenzene 2) DCE 3) Chloroform, TCA Water: 1) Xylene 2) Ethylbenzene, TCE 3) DCE, PCE	1) >1000 2) 500 to 1000 3) < 100	1) 500 to 1000 2) 100 to 500 3) < 100
Timex 20650 Valley Green Dr. Cupertino		X	
United Technologies Sunnyvale	TCE, DCE	X	
Van Waters and Rogers San Jose	Soil: 1) Xylene 2) 1,2-DCE, PCE Water 1) 1,2-DCE, PCE, Xylene DCA, TCA	1) 500 to 1000 2) < 100	1) > 1000

TABLE 7 (continued)

PAGE 7

Case Name and Community	Contaminant	Soil (ppb)	Ground water (ppb)
Verbatim Corp. Sunnyvale	1) Methylene Chloride, Thio-bis-methane 2) Dimethyl-disulfide 3) DCA 4) DCE, Benzene, Toluene	none	1) > 1000 2) 500 to 1000 3) 100 to 500 4) < 100
Western Forge & Flange Santa Clara			
Westinghouse Sunnyvale	PCB, TCB	X	X
Xidex Sunnyvale	Soil: 1) Methylene Chloride, Oxy-bis-ethanol, Heptanone 2) Xylene, Cyclopentane Water: 1) Methoxyethanol, Methoxypropanol, Methylene Chloride, Caprolactum, Hexanoic Acid, Hexanol 2) Heptanol 3) Octanol 4) Acetates, other Heptanols	1) > 1000 2) < 100	1) > 1000 2) 500 to 100 3) 100 to 500 4) < 100
Zymos Corp. Sunnyvale	Soil: 1) Xylene 2) TCE Water: 1) 1,2-DCE 2) TCE 3) DCA, Benzene, PCE, TCA, Freon	1) > 1000 2) 500 to 1000	1) 500 to 1000 2) 100 to 500 3) < 100

TABLE 7 (continued)

ABBREVIATIONS USED IN TABLE 7

DCA	Dichloroethane
DCE	Dichloroethylene
IPA	Isopropyl alcohol
MEK	Methyl ethyl ketone
PCB	Polychlorinated biphenyl
PCE	Perchloroethylene
TCA	1,1,1-Trichloroethane
TCB	Trichlorobenzene
TCE	Trichloroethylene
<	less than
>	greater than
ppb	parts per billion
X	contaminant(s) present in unspecified concentrations

TABLE 8

CONTAMINATED DRINKING WATER WELLS*Contaminated Public Water Supply System Wells

<u>Purveyor/Well</u>	<u>Contaminants/Levels</u>	<u>Current Status</u>
<u>San Jose Water Company:</u>		
Senter Road Well	TCA 2-3 ppb Freon 113 ^a 1.5-3.5 ppb	In service
Tully Well #1	TCA ND-3.5 ppb	In service
#2	TCA 2 ppb Freon 113 ^a 1-1.5 ppb	In service
#4	TCA 1.5 ppb	In service
Ridgely Well	TCA 4 - 5 ppb	Standby well
San Thomas	PCE ^b 1 ppb	
First Street #1	TCA 3 ppb	Standby well
First Street #2	TCA 3 - 4 ppb	Standby well
First Street #3	TCA 21 -28 ppb 1,1-DCE 0.8 ppb	Standby well
<u>City of San Jose Water System:</u>		
Evergreen Wells #2,#3,#4	TCA 1-2 ppb	In service
<u>California Water Service Company:</u>		
Hillview Well	Carbon Tetrachloride 10 ppb	Out of service as of 7/31/84

* State Action Levels:

TCA:	200 ppb.
1,1-DCE:	0.1- 0.4 ppb (detection limit)
Freon 113	not established
PCE	4 ppb

^a Freon 113 is a trade name for 1,1,2-trichloro-1,2,2-trifluoroethane.

^b PCE designates perchloroethylene, also known as tetrachloroethylene.

TABLE 8 (continued)

CONTAMINATED DRINKING WATER WELLS*Contaminated Public Water Supply System WellsGreat Oaks Water Company:

Well #2	Freon 113 ^a TCA	ND-12 ppb ND-2.6 ppb	Out of service as of 9/82
Well #8	TCA	ND-17 ppb	Out of service as of 2/82
Well #13 ^b	TCA	6-8,800 ppb	Out of Service as of 12/7/81

Magic Sands Mobile Home Park:

TCA	ND-2 ppb	In service
Freon 113 ^a	ND-9 ppb	

Rancho Santa Teresa Mobile Home Park:

Well #1	TCA	ND-4 ppb	In service
	Freon 113 ^a	ND-3 ppb	
Well #2	TCA	ND-7 ppb	In service
	Freon 113 ^a	ND-7ppb	

* State Action Levels:

TCA:	200 ppb.
Freon 113	not established

^a Freon 113 is a trade name for 1,1,2-trichloro-1,2,2-trifluoroethane.^b High levels are for late 1981. Lower levels are for recent tests.

TABLE 8 (continued)
Contaminated Private Drinking Water Wells

<u>LOCATION</u>	<u>CONTAMINANT LEVELS (ppb)</u>			<u>CURRENT STATUS</u>
NORTH BAYSHORE, MOUNTAIN VIEW ¹ (35 wells)				Shut down as of 7/84
	TCA	ND -	24	
	Freon 113	ND -	40	
	TCE	ND -	2800	
	Tetrachloroethene	ND -	8.5	
	Vinyl Chloride & Other Compounds	ND -	540	
	Total coliform	2 - 1,800 per 100 milliliters		
NORTHWEST OF IBM, SOUTH SAN JOSE (8 wells)	<u>TCA</u>	<u>FREON 113</u>	<u>1,1-DCE</u>	
2000' W of Int. of Cottle & Blossom Hill	ND-16	ND-35	ND	Out of Service
250' NW of Int. of Cottle & Blossom Hill	ND-3	ND-48	ND	Still in Use
1000' W of Int. of Snell & Chynoweth	ND-1	ND-9	ND	Still in Use
750' E of Int. of Snell & Chynoweth	ND-2	ND-6	ND	Still in Use
500' W of Int. of Lean & Chynoweth	68-150	38-93	1-3	Out of Service
Adjacent to Well 35	23-140	56-430	ND-3	Out of Service
At Int. of Senter & Sylvandale	ND	ND-1	ND	Still in Use
1000' SE of Int. of Senter & Sylvandale	ND-2	ND-1	ND-1	Still in Use

State Action Levels and maximum contaminant levels:

TCA	200 ppb
1,1-DCE	0.1 - 0.4 ppb (detection limit)
Vinyl Chloride	2 ppb
Total coliform	1 per 100 milliliters (Maximum Contaminant Level)
Freon 113	not established
Tetrachloroethene	4 ppb

^a Freon 113 is a trade name for 1,1,2-trichloro-1,2,2-trifluoroethane.

¹ Includes all private drinking wells that are now used for drinking or were put out of service as a result of contamination.

ND = Not Detected

SOURCES: Water purveyors, State DOHS, Bay Area RWQCB, Kleinfelder & Associates,
Private Well Sampling Report, July 1984 (Prepared for Teledyne Semiconductor).

TABLE 9

TOTAL TRIHALOMETHANE LEVELS* IN 1983 and 1984

(Average ppb)

	1983						1984					
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
SCWD Rinconada Plant	66	103	86	60	103	101	62	4	20	10	15	15
SCWD Penitencia Plant	54	76	64	52	85	78	35	62	58	56	62	50
	1983 Quarter				1984 Quarter							
	1st	2nd	3rd	4th	1st	2nd						
Hetch Hetchy Water (at Palo Alto)	61	65	72	63	64	59						

*Maximum Contaminant Level is 100 ppb running annual average.

SOURCE: SCWD
City of Palo Alto.

TABLE 10
NITRATE LEVELS IN SOUTH SANTA CLARA COUNTY WELLS

	1981		1982												1983			
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
13375 Coolidge Ave. San Martin	49	62	84	75	84	93	95	80	78	79	59	62	61	71	61	65	64	60
13800 Harding San Martin	33	37	35	50	47	34	48	51	49	50	47	39	40	26	43	61	47	36
13125 New Ave. San Martin	6	—	4	4	4	4	7	15	16	14	7	13	6	7	6	51	85	13
12300 San Martin	50	—	51	48	49	50	50	51	51	53	53	46	52	56	53	52	50	51
12280 Sycamore Ave. San Martin	20	24	24	26	23	26	24	24	24	25	25	25	29	31	28	26	26	25
12475 San Martin	18	21	22	21	22	22	21	21	20	21	21	20	23	25	23	23	22	22
605 Highland Ave. San Martin	23	27	24	25	25	24	23	23	24	25	26	25	28	31	26	25	24	24
11470 Turlock Ave. San Martin	47	49	47	49	54	49	55	54	52	49	47	49	58	65	61	58	55	59
San Martin Water Co. 109 W. San Martin Ave San Martin	17	21	16	16	18	21	24	28	26	27	24	21	24	27	24	28	33	36
Crown Ave. System 14500 Monterey Rd. San Martin	28	28	32	37	43	58	54	58	56	65	47	47	44	48	48	50	41	39
Stonerbridge Estates 14692 Knept Ct. Morgan Hill	8	10	8	15	12	10	13	13	10	12	10	9	11	12	11	11	11	11
Twin Valley 14600 Sycamore Ave. Morgan Hill	48	51	58	58	58	67	51	52	47	51	50	50	52	54	47	43	48	47
Spring Ave. Mutual 648 Spring Ave. Morgan Hill	29	33	35	35	42	38	39	33	32	35	34	33	35	35	28	30	31	28
14895 Llagas Ave. San Martin	20	22	22	20	22	22	21	20	19	21	20	20	21	23	16	20	20	19
15085 Llagas Ave. San Martin	26	31	32	30	33	32	30	31	28	31	29	30	32	34	28	32	30	—
15750 Ellis Ave. a/ Morgan Hill	89	95	87	86	87	87	84	89	84	89	86	86 86	90	95	86	89	81	77

a/ Two samples were taken in October 1982: one on October 5 and one on October 6.

TABLE 10 (continued)
NITRATE LEVELS IN SOUTH SANTA CLARA COUNTY WELLS

	1981				1982								1983					
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1215 E. Middle Ave. ^{a/} Morgan Hill	67	70	64	50	47	81	68	51	52	43	51	57 62	77	65	78	124	129	75
1700 E. Middle Ave. San Martin	36	41	42	40	--	46	39	43	42	44	41	40	44	46	43	43	46	43
13585 Center Ave. ^{a/} San Martin	43	46	44	40	43	45	46	50	52	67	62	64 65	68	68	51	47	49	55
13655 Foothill Ave. San Martin	32	34	36	32	35	35	33	34	31	32	30	29	32	35	36	36	36	27
Burnett School ^{a/} Tilton Ave. . Morgan Hill	33	34	42	32	34	39	39	42	54	51	44	43 43	50	60	57	61	71	59
Encina School Monterey Rd./s. Bailey Ave.	--	4	8	2	14	5	20	4	5	5	5	5	6	8	4	4	4	4
Sullivan's Mutual Lantz & Scheller Morgan Hill	8	11	2	12	5	18	4	24	24	26	23	25	30	35	30	30	23	23
11595 Center Ave. San Martin	32	35	35	33	37	35	35	37	35	36	36	35	38	40	37	38	38	35
Rucker School 325 Santa Clara Ave. Gilroy	5	8	8	8	9	8	6	6	5	7	6	5	8	8	6	9	9	7
Deep Hole Water Assoc Godfrey & Ferguson Gilroy	25	31	22	28	33	33	43	34	35	49	23	32	35	35	33	39	40	33
Oak Springs Water Co. Oak Springs Circle Gilroy	7	14	14	4	16	18	8	21	18	14	15	21	23	29	26	25	25	24
San Ysidro School ^{b/} 2220 Pacheco Pass Hwy Gilroy	89	98	100	100	104	104	80	72	61	68	91	95 98 95	90	98	93	93	90	89
San Martin Cellars #1 4310 Monterey Hwy Gilroy	2	8	8	7	7	1	5	5	6	3	5	5	9	2	8	8	10	8
National 8 Motel 5530 Monterey Hwy Gilroy	12	12	16	14	12	11	11	14	18	20	20	20	23	24	19	18	20	20
Santa Teresa Meadows Scholler & Lantz														31				
Webb Group Home 13540 Columer															51			

^{a/} See footnote on page 1.

^{b/} Three samples were taken on October 4, 5, and 6, 1982.

TABLE 10 (continued)
NITRATE LEVELS IN SOUTH SANTA CLARA COUNTY WELLS

		1983												1984					
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Cal. Div. Forestry	45																		
Gwinn Elem. School	28																		
Machado School	6																		
San Martin Elementary School	24																		
San Martin Winery	28																		
Wagon Wheel Motel	35																		
Angelo Ln. W. Co. Canada Rd.	2																		
Rancho Grand View Mr. Hamilton Rd.																81			
Pinochios Pizza 9325 Hwy 101 Gilroy													64						
City of Morgan Hill: ^d																			
Cochran Well								39									45	44	46
Condite Well																	36	51	
Jackson Well								31									44		
Tennant Well								40									48	46	52
Diana Well								39									48	46	52
Boy's Ranch #1								14									22	45	
Boy's Ranch #2																	21		
Dunne Well								25									31		
Main Well								38									44		

d. Highest value in month reported for some wells.

Source: Santa Clara County Health Department; City of Morgan Hill

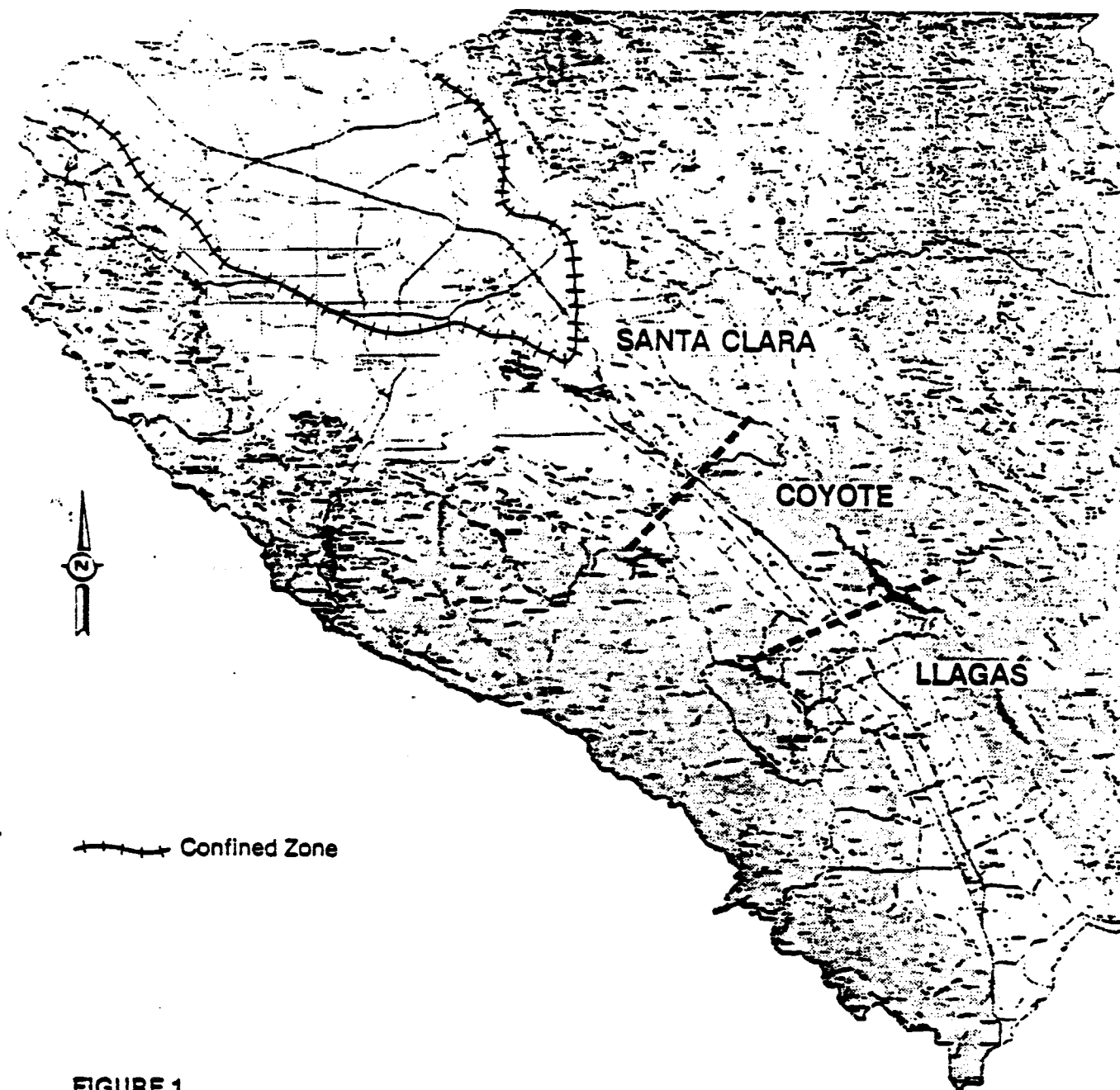


FIGURE 1
GROUNDWATER BASINS
AND THE CONFINED ZONE

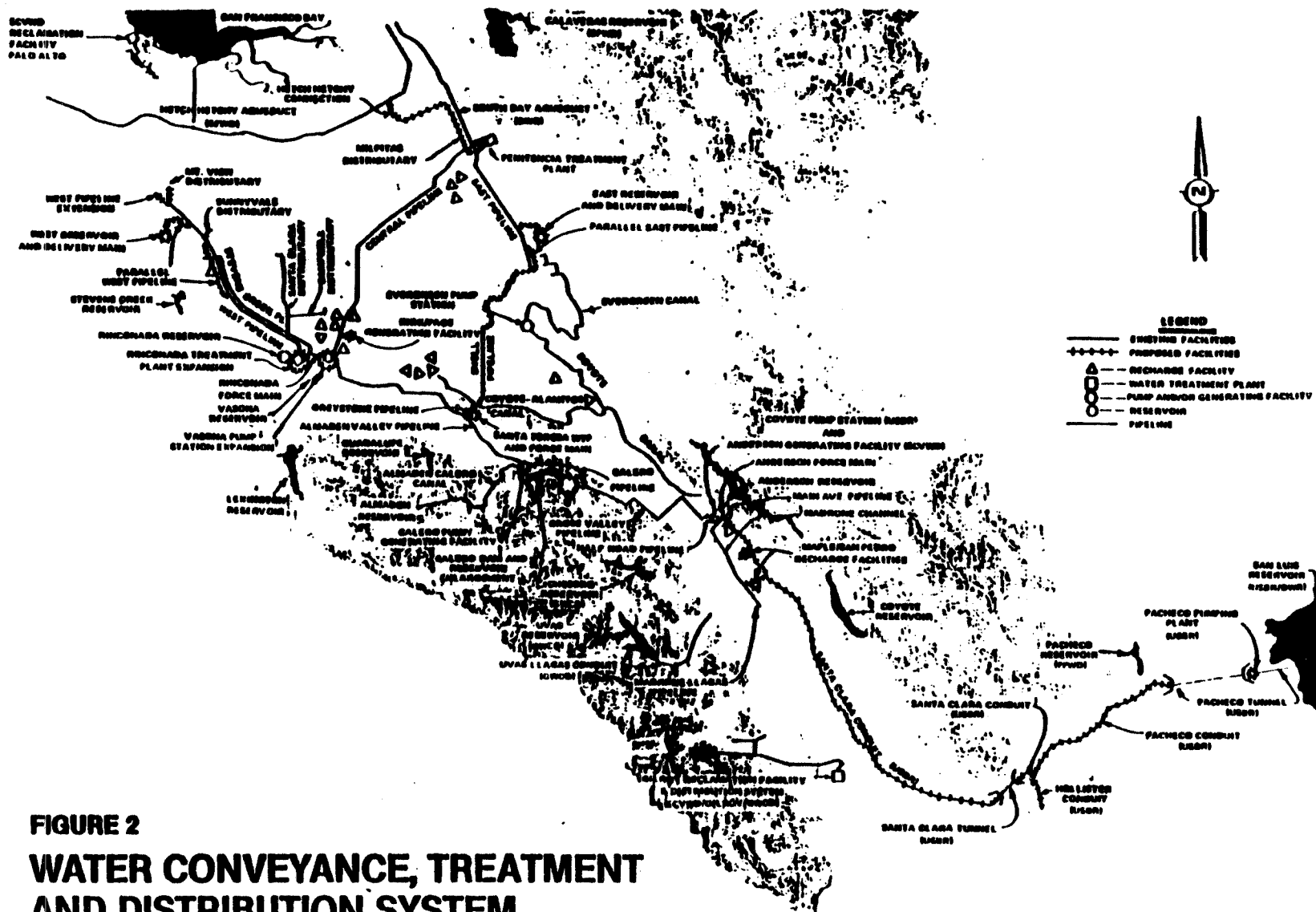
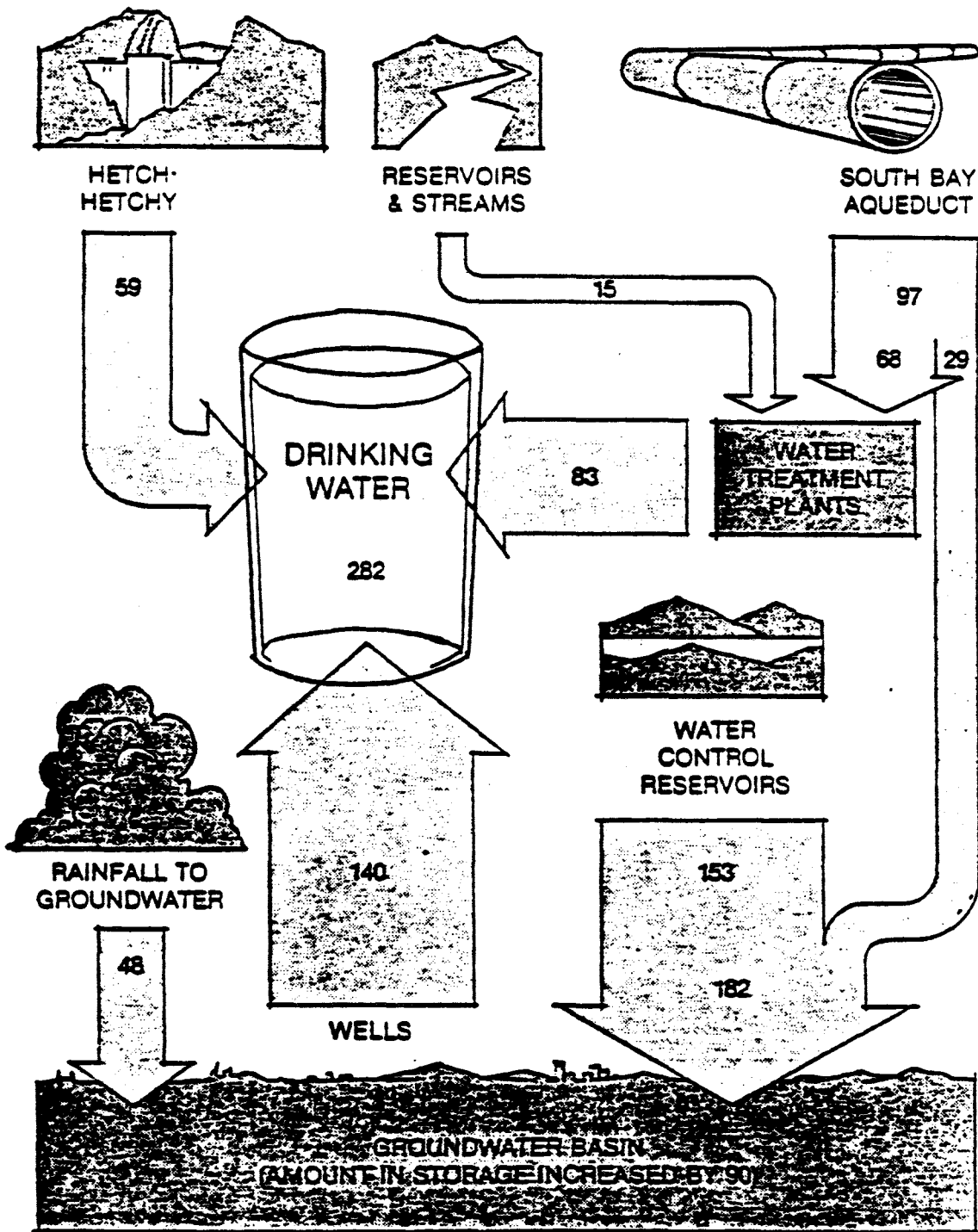


FIGURE 3

OVERALL DRINKING WATER SUPPLY PATTERNS 1980-81 (VALUES IN THOUSAND ACRE FEET)



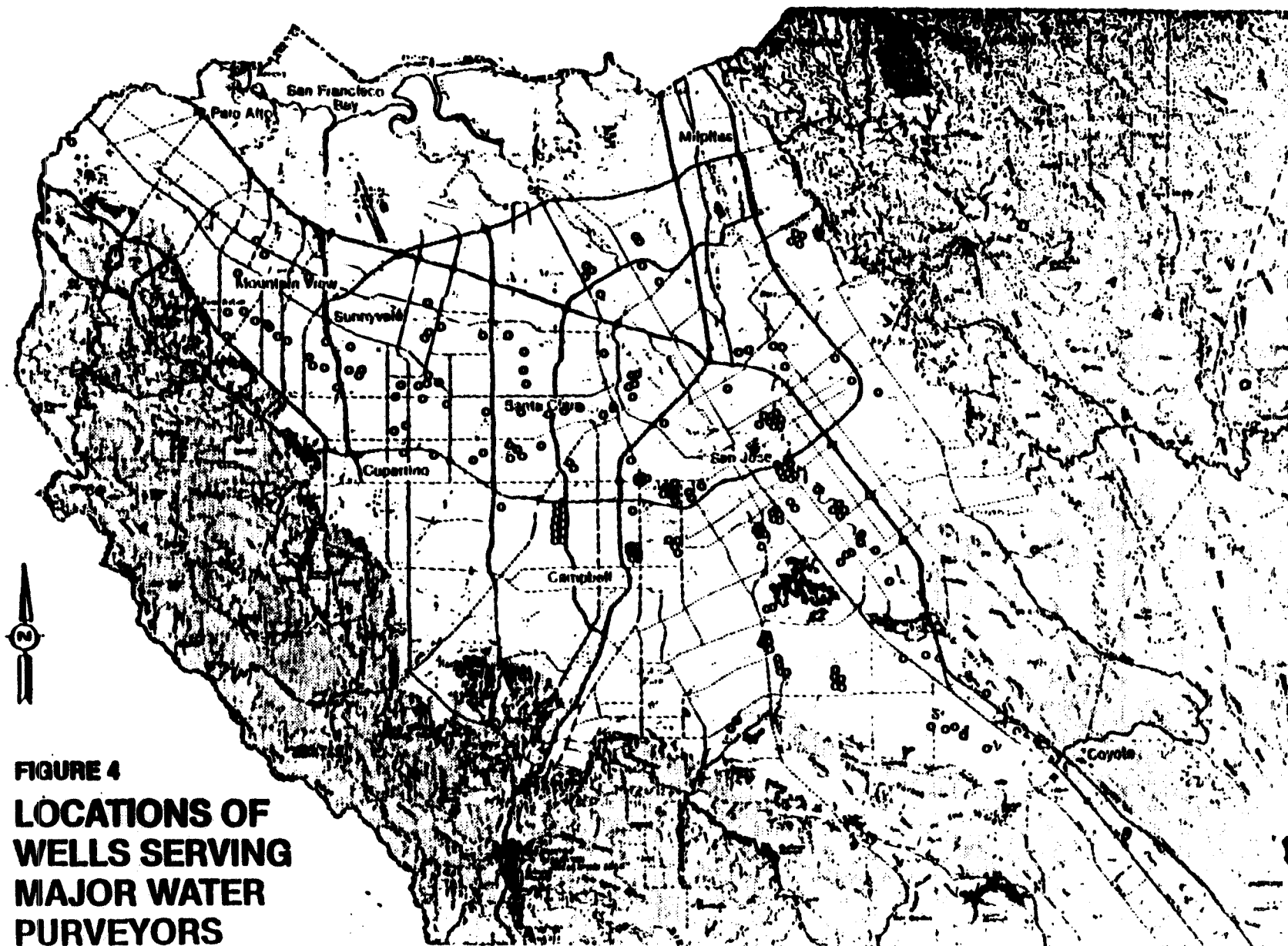


FIGURE 4
LOCATIONS OF
WELLS SERVING
MAJOR WATER
PURVEYORS

1. City of Palo Alto (City-owned)
Water supply: Hetch-Hetchy
2. City of Mountain View (City-owned)
Water supply: Hetch-Hetchy, Groundwater
3. City of Sunnyvale (City-owned)
Water supply: Groundwater, South Bay Aqueduct,
Hetch-Hetchy
4. Peninsula Hills Water District (Special District)
Water supply: Hetch-Hetchy
5. California Water Service Company (Investor-owned)
Water supply: Groundwater, South Bay Aqueduct,
Hetch-Hetchy
6. City of Cupertino (City-owned)
Water supply: South Bay Aqueduct, Groundwater
7. City of Santa Clara (City-owned)
Water supply: Groundwater, South Bay Aqueduct,
Hetch-Hetchy
8. City of San Jose (City-owned)
Water supply: Hetch-Hetchy, Groundwater
9. City of Milpitas (City-owned)
Water supply: Hetch-Hetchy

10. San Jose Water Company (Investor-owned)
Water supply: Groundwater, South Bay Aqueduct,
S.J.W.C.-operated treatment plant
11. City of San Jose (City-owned)
Water supply: South Bay Aqueduct, Groundwater
12. Great Oaks Water Company (Privately owned)
Water supply: Groundwater
13. City of Morgan Hill (City-owned)
Water supply: Groundwater
14. West San Martin Water Works (Privately owned)
Water supply: Groundwater
15. City of Gilroy (City-owned)
Water supply: Groundwater
16. Santa Clara Valley Water District (Special District)
Water supply: Groundwater, South Bay Aqueduct
(The District serves the entire Santa Clara
County with water supply and flood control pro-
grams. It is a wholesale water supplier to various
city-owned and investor-owned utilities. It
operates two treatment plants, eight dams, and
also conducts programs in groundwater
recharge, water reclamation, importation,
distribution, and weather modification.)

- A. Magic Sands Mobile Home Park (Privately owned)
Water supply: Groundwater
- B. Rancho Santa Teresa Mobile Home Park
(Privately owned) Water supply: Groundwater
- C. Cambie Mobile Home Park (Privately owned)
Water supply: Groundwater
- D. Redwood Mutual Water Company (Privately owned)
Water supply: Groundwater

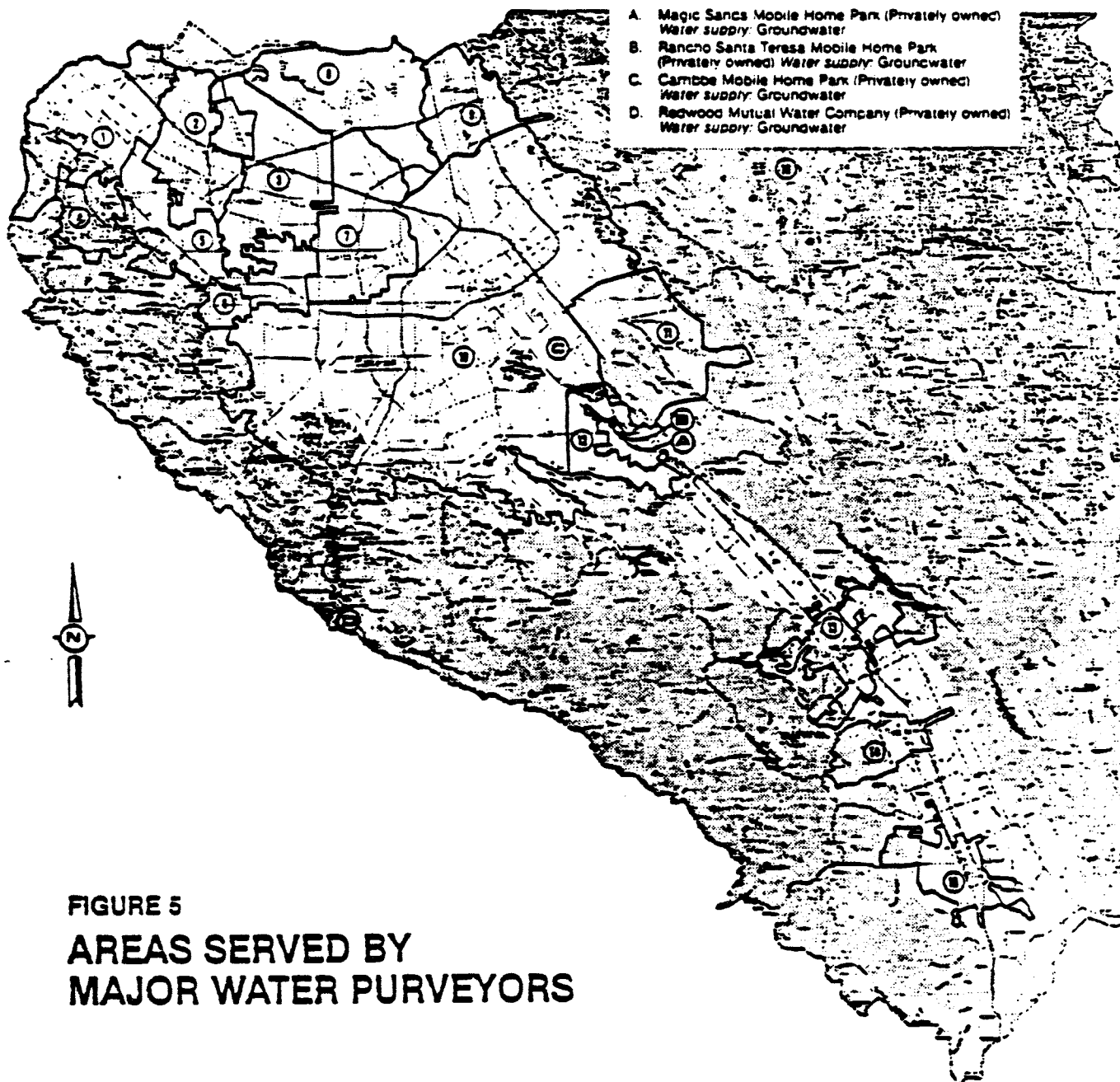


FIGURE 5
AREAS SERVED BY
MAJOR WATER PURVEYORS



FIGURE 6
SAN JOSE WATER COMPANY SERVICE ZONES

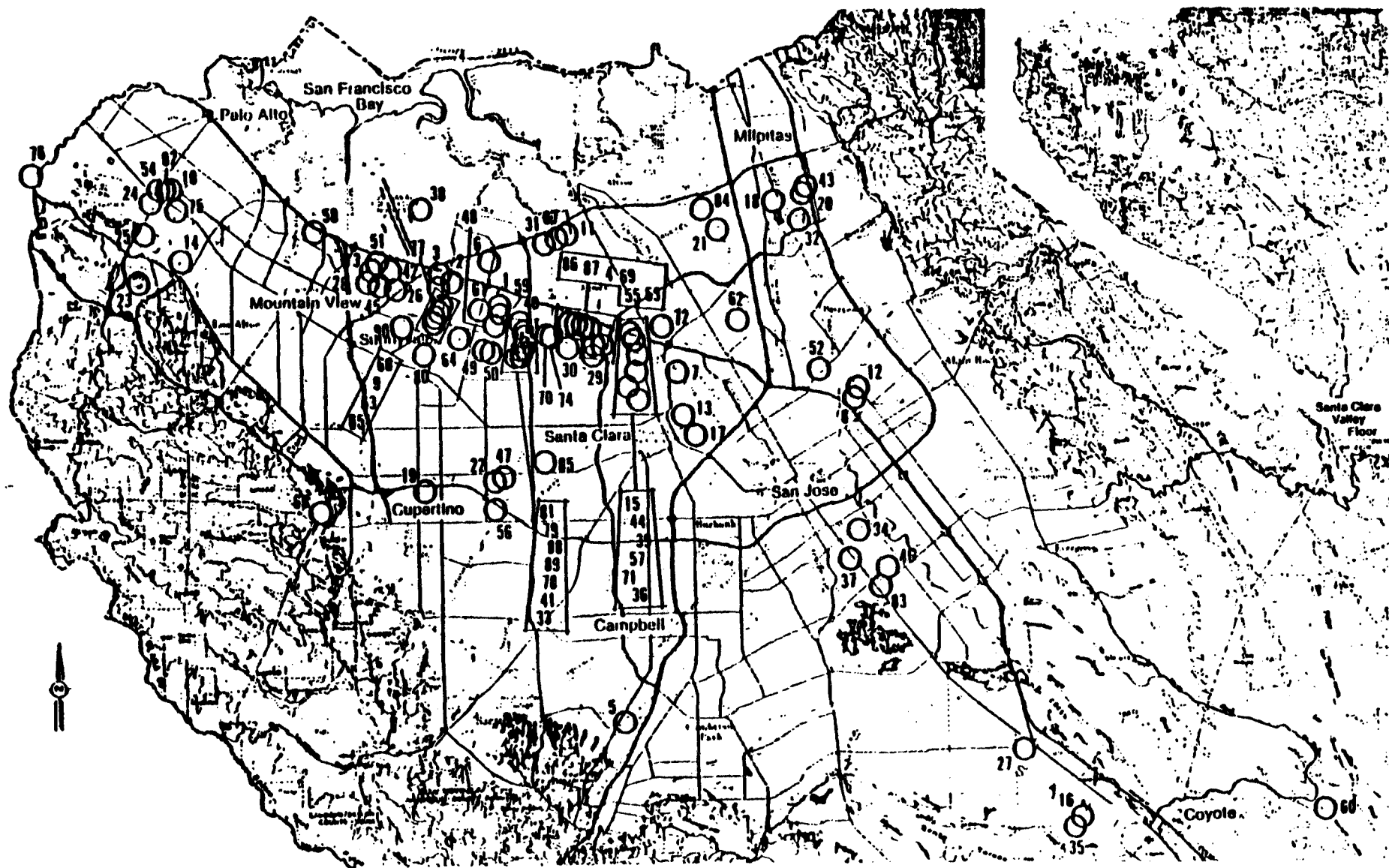
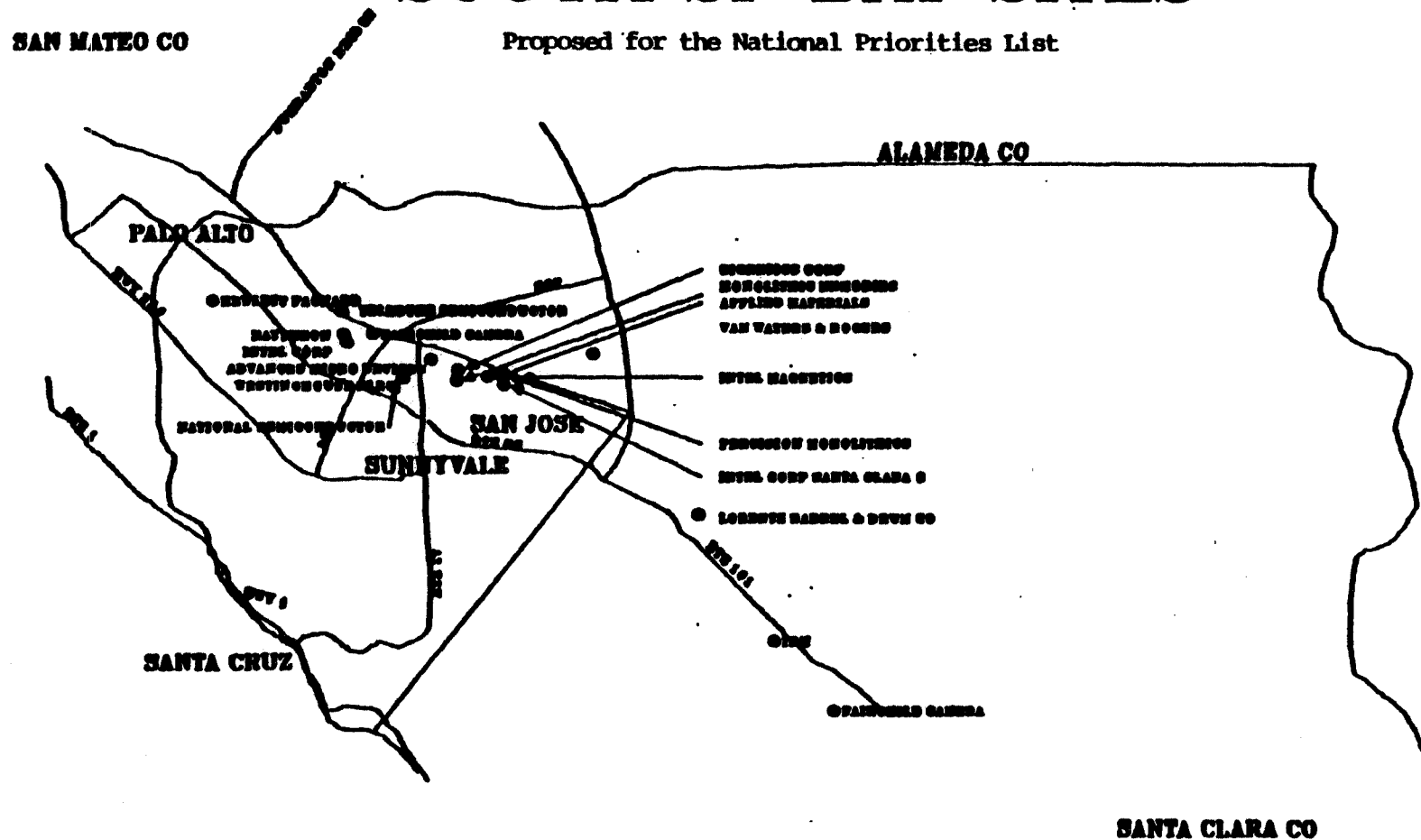


FIGURE 7 LOCATIONS OF CONTAMINATION SITES

Figure 8

SOUTH SF BAY SITES

Proposed for the National Priorities List



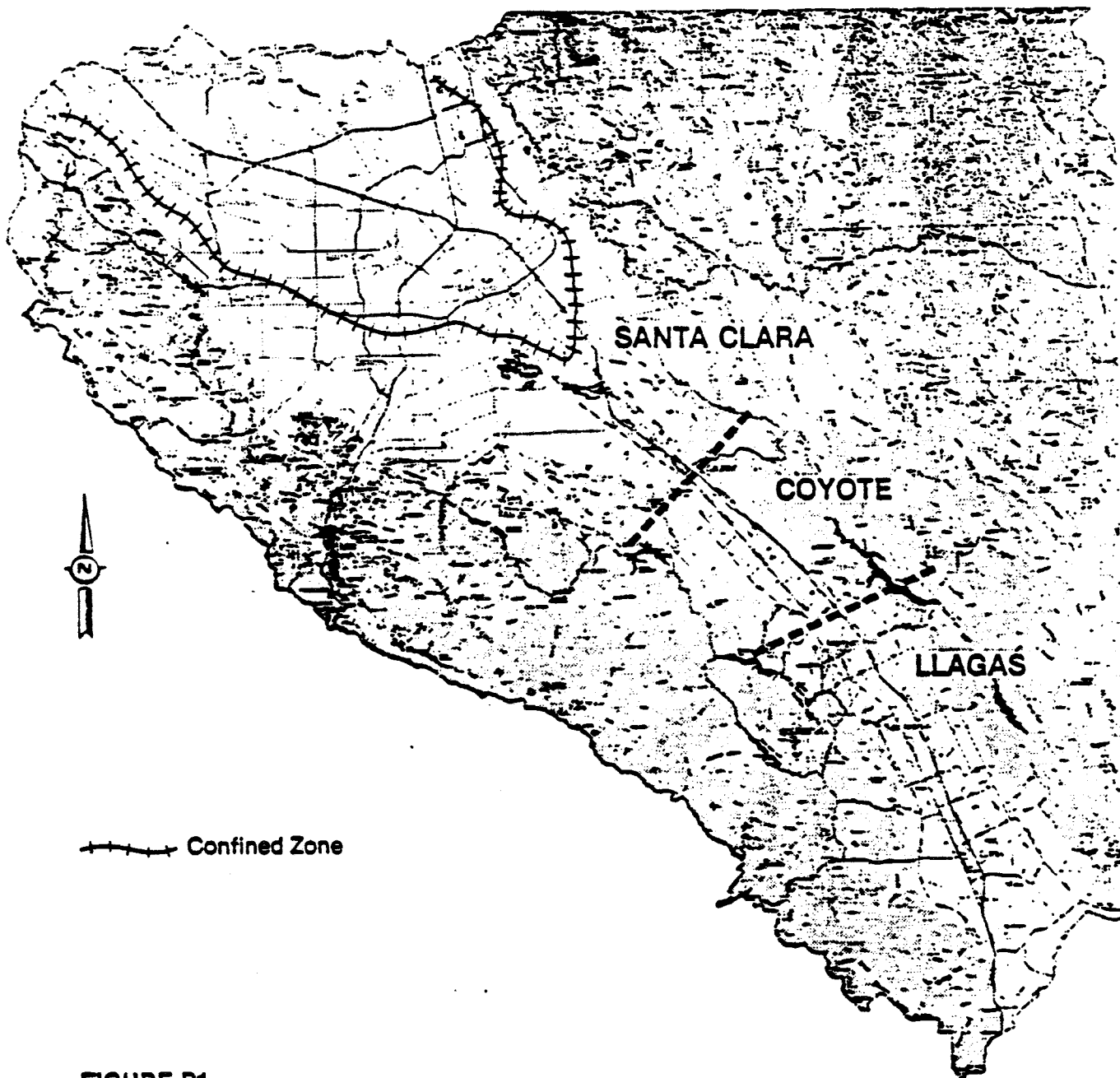
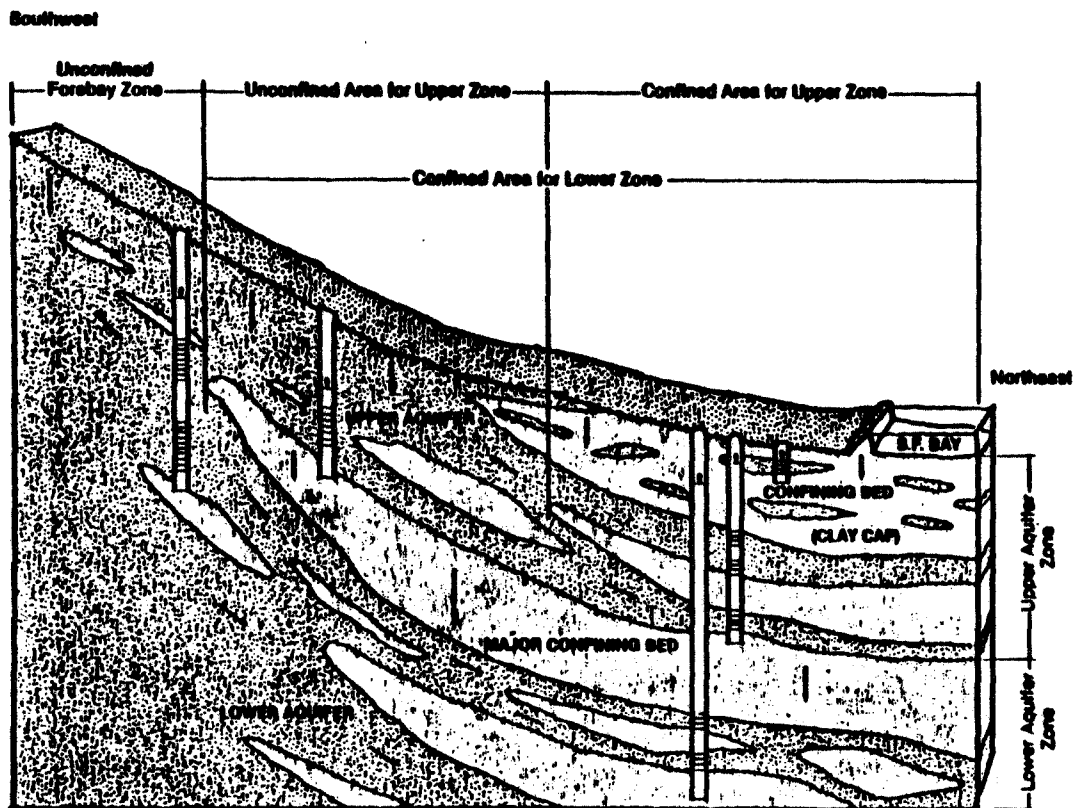
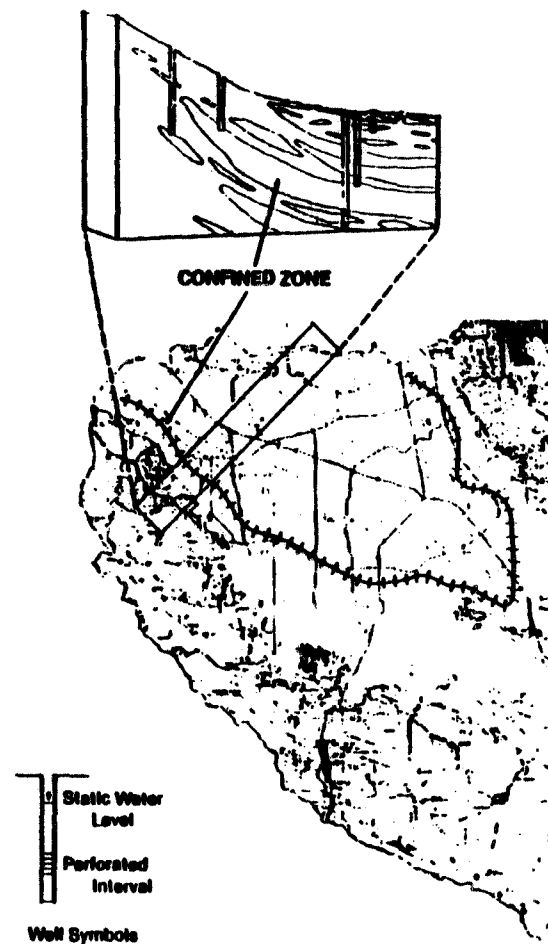


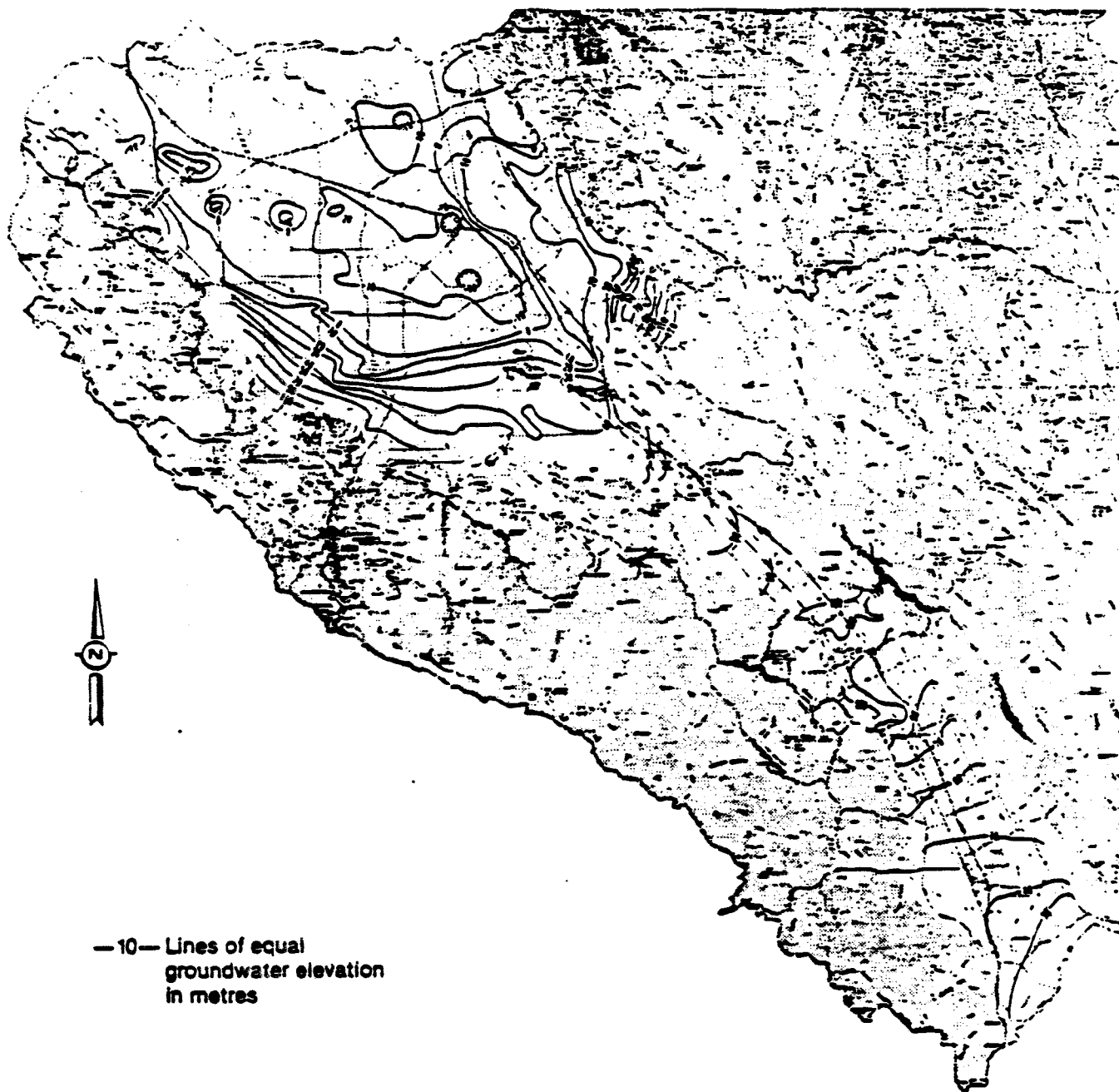
FIGURE B1
GROUNDWATER BASINS
AND THE CONFINED ZONE

FIGURE B2 SCHEMATIC CROSS SECTION FOR SANTA CLARA SUB-BASIN



Note: Arrows indicate direction of groundwater movement without regard to quantity.





—10— Lines of equal
groundwater elevation
in metres

FIGURE B3
GROUNDWATER ELEVATIONS

WELL 07S/01E-07R99
MAXIMUM ANNUAL DEPTH TO WATER

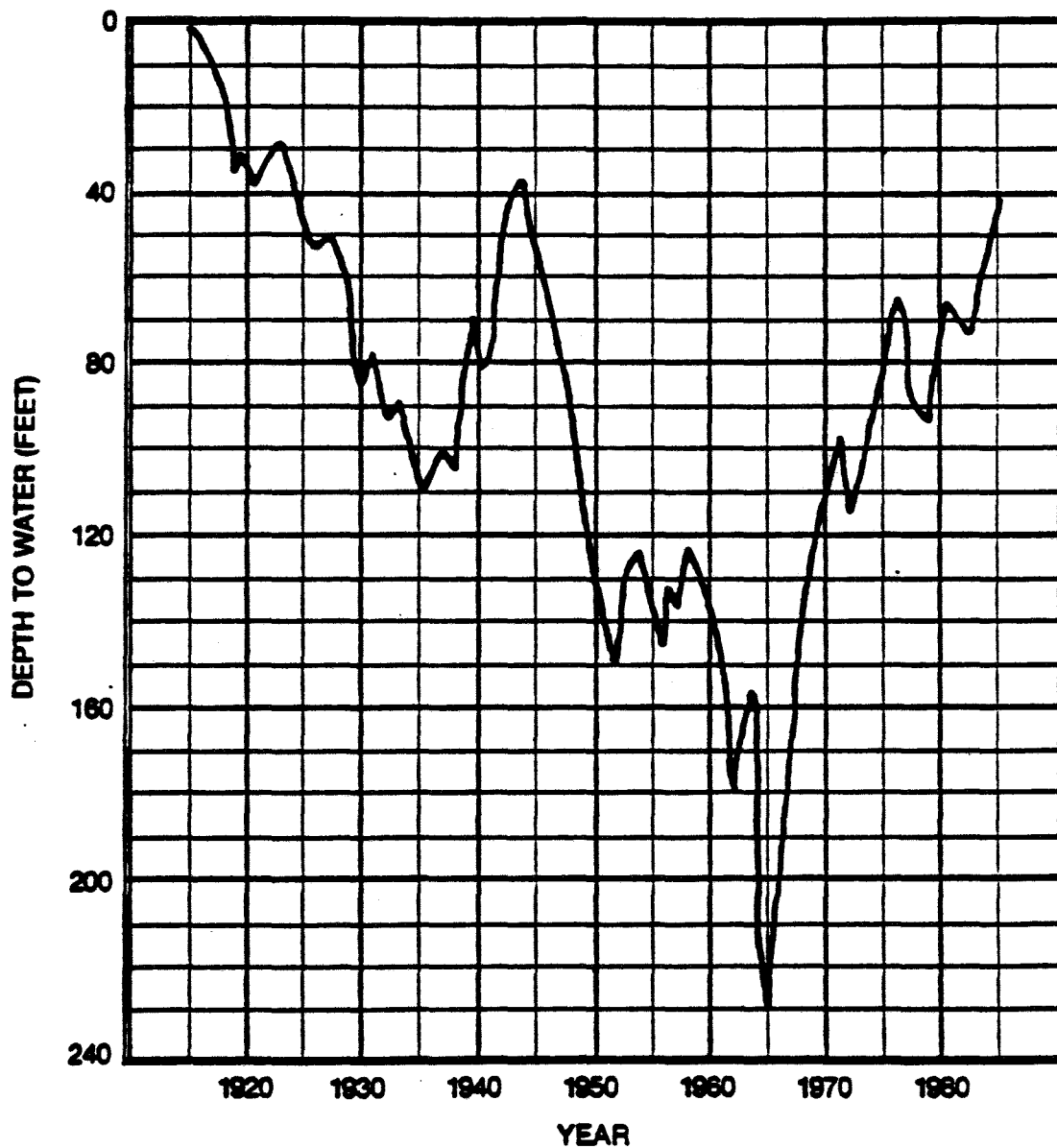


FIGURE B4
TYPICAL WATER LEVEL HYDROGRAPH
FOR SANTA CLARA SUB-BASIN

GLOSSARY

Abbreviations

CERCLA	Federal Comprehensive Environmental Response, Compensation, and Liability Act of 1980; commonly known as Superfund.
DOHS	California Department of Health Services
EPA	U.S. Environmental Protection Agency
Freon 113	1,1,2-trichloro-1,2,2-trifluoroethane
gpm	gallons per minute; one gallon per minute = 1440 gallons per day
IEMP	Integrated Environmental Management Project: EPA study of toxic pollution issues in the Santa Clara Valley.
ICC	Intergovernmental Coordinating Committee: Advisory group of local government officials for the IEMP.
MCL	Maximum Contaminant Level: Enforceable drinking water standard promulgated by EPA pursuant to Safe Drinking Water Act; applies to all public water supply systems. Based upon health effects data, existing treatment technology, risk analysis, economic factors.
PAC	Public Advisory Committee: Advisory group of government, industry, environmental, citizen, and academic representatives for the IEMP.
PCBs	Polychlorinated biphenyls
PCE	Perchloroethylene (also known as tetrachloroethylene)
POTW	"Publicly Owned Treatment Works": Wastewater treatment is typically designed to treat domestic organic wastes (sewage); POTWs also treat wastewater from industrial dischargers.
ppb	parts per billion = micrograms per liter
ppm	parts per million = milligrams per liter
RMCL	Recommended Maximum Contaminant Level: Non-enforceable recommended drinking water standard based upon health effects data; the first step in the promulgation of a final MCL by EPA.
RWQCB	California Regional Water Quality Control Board #2 (San Francisco Bay Region)
SCVWD	Santa Clara Valley Water District
TCE	Trichloroethylene
THM	Trihalomethane (includes chloroform, dichlorobromomethane, chlorodibromomethane, and bromoform).

AB 1803 State law being implemented in 1984 requiring DOHS to evaluate public water systems with ground water supplies. The evaluation must determine potential sources of contamination. Depending on the evaluation, DOHS may require a system to develop and implement a water analysis plan. Depending on the results of the analysis, DOHS may subsequently require a continuous monitoring program for a system.

Action
Levels

- 1) Unenforceable guidance levels developed and recommended by DOHS to water purveyors. When exceeded, DOHS recommends that the purveyor discontinue the use of the source unless treatment can reduce the contaminant level below the action level. If the level continues to be exceeded and no alternate supplies are readily available, DOHS recommends that users be notified by the purveyor and advised to use alternate sources, such as bottled water.
- 2) Any number of health-based, non-enforceable drinking water criteria e.g., Health Advisories, Suggested Non-Adverse Reaction Level (SNARL).

Private
Well

Any well that serves 1 to 4 connections unless it serves more than 25 non-residents more than 60 days per year; unregulated except when contamination of a well is suspected.

Small
Public

System Any system that serves 5 to 199 connections or 25 or more non-residents 60 or more days per year; regulated by Santa Clara County Health Department.

Large
Public

System Any system that serves 200 or more connections; regulated by DOHS.

One acre-foot = 43,560 cubic feet, or about 326,000 gallons

One million gallons = about 3.07 acre-feet

One million gallons per day = about 1,120 acre-feet per year

Hydrogeology

Aquiclude

A geologic formation that contains water but cannot transmit it rapidly enough to furnish a significant supply to a well or spring. Aquicludes often separate one aquifer from another.

Aquifer

A geologic formation that contains water and transmits it well enough to furnish a significant supply to a well or spring.

Aquitard

Same as aquiclude

Cone of depression

The depression, approximately conical in shape, that is formed in a water-table when water is removed from an aquifer by a well.

Confined aquifer

An aquifer trapped under a confining layer. The water in confined aquifers is often under pressure due to recharge.

Confining layer

A highly impermeable geologic formation which separates the lower (confined) aquifer from the upper (unconfined) aquifer. Large horizontal aquicludes that overlay aquifers are confining layers.

Confined zone

The region between the Bay and the recharge zone. The boundaries of the confined zone are determined by the extent of the major confining layer in the Santa Clara Valley. Those boundaries are shown in Figure 1.

Ground water flow rate

The speed at which water moves in the subsurface. Ground water flow rates depend on hydraulic gradient, porosity, and permeability.

Hydraulic gradient

The slope of the water table in an aquifer.

Permeability

A measure of the ability of a geologic material to transmit water.

Porosity

A measure of the amount of space between soil particles. Soils with relatively high porosity are able to hold relatively large volumes of water.

Recharge zone

The area outside the confined zone; more generally, an area in which water readily percolates from the soil surface into deeper zones to replenish the water in an aquifer.

Specific yield

The ratio of the pumping rate of a well to the drop in water level in that well during pumping. This ratio is used to estimate transmissivity.

Transmissivity

A measure of the volume of water that can pass through a certain cross section of a geologic zone, such as an aquifer. For material of a given permeability and porosity, and for a given hydraulic gradient, a thicker aquifer will be more transmissive than a thinner aquifer.

Hydrogeology

Aquiclude

A geologic formation that contains water but cannot transmit it rapidly enough to furnish a significant supply to a well or spring. Aquicludes often separate one aquifer from another.

Aquifer

A geologic formation that contains water and transmits it well enough to furnish a significant supply to a well or spring.

Aquitard

Same as aquiclude

Cone of depression

The depression, approximately conical in shape, that is formed in a water-table when water is removed from an aquifer by a well.

Confined aquifer

An aquifer trapped under a confining layer. The water in confined aquifers is often under pressure due to recharge.

Confining layer

A highly impermeable geologic formation which separates the lower (confined) aquifer from the upper (unconfined) aquifer. Large horizontal aquicludes that overlay aquifers are confining layers.

Confined zone

The region between the Bay and the recharge zone. The boundaries of the confined zone are determined by the extent of the major confining layer in the Santa Clara Valley. Those boundaries are shown in Figure 1.

Ground water flow rate

The speed at which water moves in the subsurface. Ground water flow rates depend on hydraulic gradient, porosity, and permeability.

G-4

Hydraulic gradient

The slope of the water table in an aquifer.

Permeability

A measure of the ability of a geologic material to transmit water.

Porosity

A measure of the amount of space between soil particles. Soils with relatively high porosity are able to hold relatively large volumes of water.

Recharge zone

The area outside the confined zone; more generally, an area in which water readily percolates from the soil surface into deeper zones to replenish the water in an aquifer.

Specific yield

The ratio of the pumping rate of a well to the drop in water level in that well during pumping. This ratio is used to estimate transmissivity.

Transmissivity

A measure of the volume of water that can pass through a certain cross section of a geologic zone, such as an aquifer. For material of a given permeability and porosity, and for a given hydraulic gradient, a thicker aquifer will be more transmissive than a thinner aquifer.